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Details of construction and operation of the latest mucking machine

By Charles E. van Barneveld

How to Select Equipment for Prospecting and Exploration Work

By George J. Young

Rubber Lining for Tube and Ball Mills

In successful use by the Nipissing Mines Co.

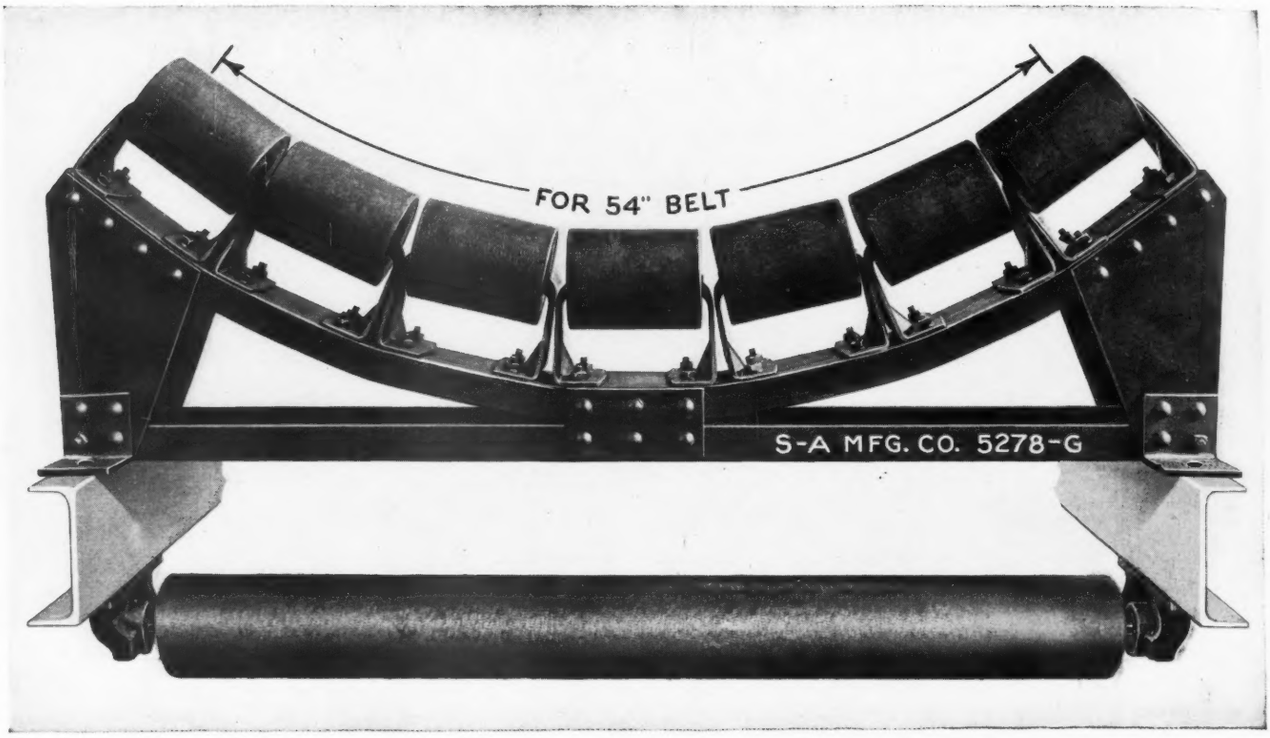
By Arthur B. Parsons

Efficiency and Power Requirements of Fans

By Walter S. Weeks

A WEEKLY JOURNAL REPRESENTING THE WORLD'S MINING AND METAL INDUSTRIES

September 22, 1923



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ENGINEERING & MINING
JOURNAL-PRESS
JOSIAH EDWARD SPURR, Editor

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Accomplishments at Reno

THE OUTSTANDING DEVELOPMENT of the Reno silver conference, held early this month, was the passage of a resolution advocating the formation of a Silver Export Association. The silver miners and smelters have decided to take advantage of existing legislation and to use business methods to improve their position—which is wise and sensible. Hence, they probably will form an export association, just as the copper and phosphate producers have done, under the provisions of the Webb-Pomerene Act. It remains to be seen what the organization can do for the white metal. The experiment will be worth a fair trial and it is to be hoped that producers will co-operate as heartily in joining the association as they did in the deliberations which will lead to its formation. Incidentally the producers are indebted to Senators Pittman and Oddie, of Nevada, for initiating the plan to bring them together for a frank discussion of the situation.

But the silver miners must not be deluded over what they can collectively accomplish in the export field. Primarily, their association should have as its object the establishment of a selling machine to offset any united buying of American silver by consumers abroad, and to effect economies in marketing. Silver is sold, however, on an exceedingly small margin and the improvements that can be made in that respect are likely to be of minor consequence. Mr. C. F. Kelley's words of caution at the conference were well chosen and should be weighed carefully. The Anaconda Copper Mining Co., of which Mr. Kelley is president, produces more silver in the United States than any other mining company, so that it has a larger stake in any action which affects the silver market than any other fellow producer. Mr. Kelley emphasized the thought that it is a mistake to allow the idea to be disseminated that "we are going to wrest control of the silver market from London." He also dwelt upon the serious problems that would have to be solved in the functioning of an export association. His frank realization, and presentation before the conference, of its limitations is far better than a delusion as to its power. If a silver export association shows a saving for the silver producers, it will prosper; on the other hand should its cost of maintenance be greater than its economies, we may look for its early demise. In the last analysis, there are two methods of improving the price of silver. One is by stimulating demand; the other by decreasing supply. Any effort to establish an artificial condition in the industry—that is, a certain price for silver regardless of these two factors—is predestined to certain failure.

Even though the proposed Silver Export Association may not do wonders for the silver miners, it provides an opportunity for them to get together which they do not now possess. Under the law it is a serious offense to combine with one's competitor in order to set a price for a commodity. The Webb-Pomerene Act legalizes such activities provided only foreign markets are dealt with; there must be no disturbance of the domestic open market. Silver producers need not have any fear of the specter of a penitentiary sentence hanging over them in their discussions of export markets under the Webb Act. Most of the American produced silver goes abroad, so that sales to Europe and Asia are more important than those in the local market. In the long run it may be discovered that the Silver Export Association will accomplish the most through laying a groundwork for co-operation in the industry and focusing the collective abilities of the producers on the solution of their problem, rather than in a direct stimulus to prices.

Mechanical Mucking

MORE THAN ONE company during the war, when shovelers were scarce, experimented or made up its mind to experiment with underground loading machines to see if in them lay a remedy for the labor shortage. But as workers became easier to find, after the armistice, many operators abandoned their efforts in this direction, preferring mucking by hand because it was possibly a little cheaper than the experiments with machines, whose proper use they had not mastered. Perhaps another reason was that it was easier to let the other fellow do the experimenting, make the mistakes and try and try again, incidentally paying the bill for the progress made. Pioneering is ever done by the few, though success has a host of imitators. Experimentation costs money and requires brains and initiative, hence it is generally left to others.

In the greater use of machinery lies the principal solution of the problem caused by labor scarcity. Indeed, even were labor to become and remain most plentiful, the natural tendency of civilization would make for improved ways of doing things and for the supplementing of man's efforts with mechanical aids. Jules Verne had a riotous imagination and wrote of many wonderful things, unknown in his time, which since have come to pass. Underneath that imagination lay a shrewd estimation of man's ability to work his way upward and gradually to conquer all difficulties, including the elements.

The labor problem has come to stay. At least no influx of workers from foreign shores may be expected. Modification of the immigration law will probably be but slight. To throw the nation's doors wide open for the paupered hordes of Europe would temporarily give an abundance of workers, but is not likely to be tried. Not only is organized labor against it, but there are few others who in their hearts wish to see the country's foreign population increase materially. This great country is none too big for the 110,000,000 population that inhabits it, when the future is considered. Already

the medley of tongues is far too great. A mixture of peoples that will not blend is highly undesirable. The evils of this became apparent in the war. More ultimate harm than good can come from carelessness and thoughtless liberality in admitting aliens.

Given a definite population in every decade, it is doubtless possible to make it suffice for the nation's labor requirements, with proper mechanical aid. Indeed it is probable that mechanical ingenuity properly applied will outstrip the normal increase in population.

What a tremendous amount of human effort is thrown away with the nation's industrial waste! Conversely, what a saving in the man power that produces the country's wealth there would be if industrial waste were lessened! Translate into terms of man power the waste of coal improperly burned and needlessly hauled. Here alone is an enormous loss that can be avoided by improved power plant practice and by the greater use of generators and electric transmission equipment. And this is only one part of the industrial field.

Much experimental work has been done with mechanical underground loading. A number of machines of different types, designed to meet different conditions, have been developed and are being used or experimented with to a varying extent. None of those on the market has proved itself the universal substitute for the good old-fashioned muck stick plus elbow grease. Slushing with scrapers underground has been experimented with in a number of places and has undergone a remarkable development. The mechanical shovel for which everyone is looking still has to win recognition. The latest to be designed, invented by Robert S. Butler, of the Barnsdall Zinc Co., at Waco, Mo., is described in considerable detail in this issue. It promises much in its seeming adaptability to average underground conditions and it will be watched with interest.

One does not have to be a Jules Verne to foresee the day when the handling of ore mechanically will be the rule underground rather than the exception as at present. Every experiment made, every shoveling machine purchased for trial or for regular operation, brings the day so much nearer. Operators who tried and abandoned mechanical mucking and those who have never tried it at all would do well to study the subject carefully to see if it will not help them to meet their present needs.

Platinum Inquiries Continue

WORDS HAVE WINGS and fly to the furthest points to which man and the printed page can take them, and long after they have been uttered they may register their effect. Despite all this, important utterances often fail to reach those for whom they are intended. Only a few weeks ago the U. S. Bureau of Mines issued a report on platinum assays and platinum promotions, in which a definite statement was made that the platinum resources of the United States were negligible. That is to say, the platinum production of the country was infinitesimal and no discoveries had been made or were being worked that were worth a whoop. This report is interesting to anyone on general principles, and those who are concerned about platinum for any reason will find it well worth reading. It is designated as Serial No. 2496, *Reports of Investigations,* and is obtainable free from the Bureau in Washington.

Wide publicity was given this report, and yet inquiry comes as to the Erie Gold & Platinum Co., at Ward, Colo. The statements in the company's prospectus, which is exhibited by the inquirer, is typical of the many that were investigated by the Bureau. The prospectus has a look of fairness and squareness about it because of the mine assays tabulated. Who would give mine assays unless they were so? Who, indeed! A Philadelphia laboratory is listed as reporting from a half ounce to 14.2 oz. platinum per ton. Another assayer in Denver reports $2,300 in platinum from one ton of ore "from the dumps," in a test run, and still another recovered $2,500 or thereabouts. Two assays made by the Bureau's experiment station at Golden (since moved to Reno) are said to have given values of 0.03 oz. and 0.21 oz. respectively. The report of the Bureau itself says that small quantities of lode platinum were detected in samples from Boulder County, Colo., in which Ward is located, so it is not impossible that the Erie company may actually have some platinum in its ore. It is extremely doubtful, however, that any bonanza occurs as that indicated by the assay results given above. It would be interesting to know how the high values reported by the other assayers were obtained. In every case where such high assays were investigated by the Bureau only small quantities of platinum or none at all were found.

Better Ore Contracts

THE RIGHT TIME to get fair terms for selling your ore is before you attach your signature to the smelting contract. Occasionally, smelter managers have taken advantage of the inexperience of a miner and tied him up with rates that assure the smelter an exorbitant profit. If the mine amounts to little, the buyer may modify the terms; but if it turns out to be a bonanza he simply puts on the screws. That is what happened a few years ago in the case of a well-known silver producer out west. The story of how the smelter manager recently was induced to cut $12 per ton from a treatment charge that he always has contended was leaving him no profit may suggest to others ways and means for getting more favorable terms, even though there probably is no other situation comparable to this. On the other hand, it may show how to avoid the necessity of shipping to a smelter by treating high-grade concentrate at the mine.

The product shipped was sulphide concentrate that averaged around 300 oz. silver and a little more than 1 oz. of gold per ton. Deductions from the full gold and silver content, a high nominal treatment charge, and a penalty for arsenic and antimony brought the actual smelter charge up to about $40.50, to which was added $15.50 per ton for freight, making a total marketing cost of about $56 per ton. The mining company contended that the terms were inequitable, but the smelter manager pointed to his bond.

As an alternative it was decided to devise a method of treatment at the mill; work to this end the company's metallurgist undertook more than a year ago. Laboratory research with both wet and dry methods indicated that the best results would be obtained by smelting with California trona as a flux. A small reverberatory furnace 4 by 6 ft., was constructed. Smelting the raw concentrate proved impracticable, but a preliminary roast removed most of the arsenic, much of the antimony and all but 4 or 5 per cent of the sulphur and made an excellent calcine for smelting with lead to form

base bullion. This was cupelled to make fine bullion for shipment to the mint. The slag ran 1½ oz. silver and the dust and flue losses were not out of reason. Allowing for all losses and for the cost of operation the concentrate was treated for $28 per ton, thereby making a saving of about $28, or $560 per day, on the current production of 20 tons of concentrate daily. A first-class furnace-man was employed and plans were drawn for a small smelter to be erected at a cost not to exceed $100,000.

By this time the smelter officials had become convinced that the mining company meant business. They asked and were accorded permission to investigate the work. Then they tried to persuade the president of the company that his operating staff could not do what it claimed. This availed nothing, so a conference was arranged. The mining company laid its figures on the table. After the customary tender of two or three "best and final" offers had been followed by others an agreement was reached. The smelting company found it "economically" possible to cut its charge $12 per ton and the railroad company contributed a cut of $3 on the freight rate. Even at that we understand the mining company would have built the smelter if it had had high-grade ore blocked out for two years' operation at the capacity it had been maintaining. It is true that the smelting company has realized greater cash profit on this contract than it would have done if a fair schedule had been offered in the first place. At the same time its policy has not gained it any good will—and good will is an asset not to be ignored. Fortunately, we believe, most smelter officials nowadays are doing business with that thought in mind.

The Mesabi of Tomorrow

PROPHECY is risky business; nevertheless we venture to predict that before many years the Mesabi iron range of Minnesota will be able to boast more and larger ore-dressing plants than any other equal area in the world. There are today a number of plants where log-washers, screens, and in some cases concentrating tables are being used to remove a few per cent of silica from the hematite ores. Some of them handle a comparatively large tonnage; but the only plant that can really be said to be using concentration, as the term is generally understood, is that of the Mesabi Iron Co. at Babbitt, where magnetite ore containing only 30 per cent iron is being ground and concentrated. The filtered concentrate ranging from 10 mesh to finer than 200 is sintered to form an ideal blast-furnace feed.

The engineer who is a stranger on the range is impressed with the hugeness of the open pits; with the skill displayed in handling large tonnages of material. The men in charge have developed wonderful efficiency in drilling and loosening the soft rock; in loading it with steam and electric shovels; in hauling it over intricately designed systems of trackage. They are experts at mixing ore from various sources so as to get the most desirable cargo at the dock; they have devised and keep complicated records made necessary by a cumbersome leasing system. They have splendid shops and they keep their heavy equipment in first-class repair. The underground mines, like the washing plants, are largely eclipsed by the vastness of the open-cut operations. Probably 85 per cent of the ore mined is loaded by steam shovel into cars that take it without transfer to the docks at Duluth. Today the dominant note is railroading: earth moving.

But what of tomorrow! The supply of ore containing upward of 50 per cent iron that can be mined and shipped directly to the blast furnace is large; but the day is in sight when it will be exhausted. Long before that time comes measures should be taken to utilize the almost limitless reserves of low-grade ore that are known to exist. Surely it will be cheaper to dress the ore at the mine than to haul silica to blast furnaces and there dispose of it. There arises the question of competition with iron ore from other localities, but many economic factors favor the Minnesota range, so that it seems safe to conclude that the low-grade ores will be mined. And when they are mined they will be dressed in immense plants. The process used in the present washeries no doubt will be altered and improved; new schemes of concentration will be developed. Jigs and other machines may be used. Coincidentally more plants will be built to treat the taconite, as the magnetite ore is called. The process used at Babbitt now promises to be a success, but it would be rash indeed to say that it will not be improved upon greatly. The next step should be the roasting of the lower grade hematite ore so as to convert the non-magnetic oxide into magnetite. It will then be amenable to the treatment used for the native mineral. E. W. Davis, superintendent of the Minnesota School of Mines Experiment Station, has already demonstrated the practicability of this procedure. Technically there is nothing to interfere. It seems probable that there will some day be many plants consisting of the following departments: crushing, roasting, grinding, concentrating, dewatering and sintering.

The Mesabi Iron Co. has proved that a profit can be made by doing all of these things but roasting to a 30 per cent magnetite ore. It ought to be possible to equal the results on a 40 per cent hematite ore, even allowing for the cost of roasting. The low-grade material is at hand; the deposits are near the surface; equipment for mining and hauling will be there when the high-grade hematite deposits have been exhausted. And unless we are greatly mistaken the ore-dressing plants will have been built long before that time comes. How many years will that be? Well, not so many as most people think.

A 1,000-Ton "Hot-air" Smelter for Nogales

WE TRUST that it is not too late to warn the residents of Nogales, Ariz., against the latest get-rich-quick scheme that has selected that city as a site for its machinations. The company is known as International Smelters & Refiners (Nogales) and purposes to erect a 1,000-ton smelter, making use of our old friend the Rodrian Electro-metallurgical Process, to which we paid our respects in the issue of Jan. 6, 1923. This is one of those processes which claim to get more metal out of an ore than analysis shows to be in it. "By the Rodrian dry process ores running no higher in value than $15 a ton by ordinary assay tests can be made to yield sometimes over $100 a ton." Not to the stockholders, however, we venture to say. "The wonderful results obtained by the Rodrian process will be appreciated when it is stated that practically every cent of metallic value in ore is recovered by its treatment. On the other hand over 75 per cent of values is lost by the old-time methods of smelting." Just how old-time? Even in the days of Confucius, as we recall, a 25 per cent recovery was considered sufficient cause for firing the metallurgist.

Engineers of Note

LESLIE URQUHART

By W. A. Doman

THE name of Leslie Urquhart is well known to engineers and others throughout the world, not only on account of the large non-ferrous base-metal industry which he created in Russia, but for his continuous and strenuous efforts to obtain for British mining companies the return of their Russian properties confiscated by the Bolsheviks. Born on April 11, 1874, Urquhart, after preliminary education abroad, studied engineering at Glasgow Engineering College, and chemistry at Edinburgh University. Naturally of an active disposition, and a believer in the policy of "room on top," he was keen on getting into the business world, and in 1896 he joined his father in his undertakings in the Caucasus, thus making himself, at an early date, acquainted with Russia and Russian conditions. Unlike many residents in that vast empire, he gained a thorough mastery of the language, and consequently understood the psychology of the people, both ruling classes and peasants. His career has been varied, for he saw and did not miss opportunities. In 1900 he was appointed managing director of the Schibaieff Petroleum Co., at Baku, and director of the Bibi Eibat Petroleum Co.; and in the following year he became general manager of the Russian Petroleum and Baku Russian companies. These four British oil companies, during his management, produced about 30 per cent of the total production of petroleum in the Russian empire. While at Baku he was appointed British Vice-Consul, and for his famous night ride, during the revolutionary period, to save some employees at an outlying oil field, he was decorated with the Albert Medal, first class, for conspicuous gallantry in saving life. Convinced of the mineral wealth of Russia, he formed in 1907 the Anglo-Siberian Co., took up the Kyshtim Estates in the Ural Mountains, personally reorganized the whole business, and subsequently formed the Kyshtim Corporation. A few years later he took up and developed copper mines in the Bashkir country, Orenburg, subsequently forming the Tanalyk Corporation for their exploitation. To further British mining interests in Russia he formed at this time the Russo-Asiatic Corporation, through which he took up the Ridder mines in the Altai Mountains, and, soon after the outbreak of the Great War, formed the Irtysh Corporation to take over the Ridder mines and the Ekibastous collieries and railway, which had been subsequently acquired. About $45,000,000 of capital and profits had been invested in these businesses, which, in 1919, were amalgamated in the Russo-Asiatic Consolidated, Ltd., with a capital of $45,000,000. The principal features were: Freehold and leasehold mining, agricultural and forest land, mining claims and concessions in the Urals and western Siberia, covering an area of 2,500,000 acres; twelve developed metal mines with 7,260,000 tons proven ore reserves of a profit value of more than £20,000,000; coal mines with an annual capacity of 400,000 tons and practically unlimited reserves, which are being developed for yearly output of 2,000,000 tons of coal; two copper-smelting plants with an annual capacity of 14,000 tons of copper; an electrolytic copper refinery with an annual capacity of 14,000 tons; a lead plant, the annual capacity of which is 12,000 tons of lead; a zinc plant with a yearly capacity of 24,000 tons of zinc, now 50 per cent completed; iron mines, blast furnaces, rolling mills, foundries, and steel works, with an annual capacity of 24,000 tons of finished iron and steel products; cyanide and gold mills having an annual capacity of 70,000 tons of gold ore; and two slimes and bullion refineries for the production of gold and silver. Also, great coal crushing and coking plants, railroads and a river fleet of eight steamers and twenty-four barges. Apart from these companies, Leslie Urquhart has his own varied mining interests in Russia, ranging between platinum and gold mines in the Ural Mountains and claims in Chinese Mongolia. He has recently engaged actively in mining in France, and is thoroughly investigating other mining possibilities, including certain of the British colonies.

LESLIE URQUHART

Mr. Urquhart is a director of the Var Oil & Coal Co., which has concessions covering 3,411 acres in the south of France. All in all, he is a remarkably active individual.

Rubber Lining for Tube and Ball Mills

Use at Nipissing Demonstrates Marked Economies—Capacity of a 4-Ft. Mill Largely Increased by Substituting Rubber for Iron

By Arthur B. Parsons
Assistant Editor

MOST of the roads around Cobalt, Ont., are rough and rocky; to this fact may be traced the successful development of a soft rubber lining for ball or tube mills that has substantial advantages over iron linings. Naturally there are several intermediate links in the chain of circumstance. One is an automobile belonging to James J. Denny, metallurgist for the Nipissing Mining Co.; another is his creative imagination, analytical instinct or whatever the spark of genius is that marks the inventive mind. The scheme is simple enough; most innovations are after someone has showed the way. The wonder is that no one ever tried a rubber liner before.

One morning a little more than two years ago—I have the story from a mutual friend who lives in Cobalt—Mr. Denny sat on the steps of his office contemplating the cord tires on his heavy touring car. Bearing in mind the rough roads hereinbefore mentioned he marveled at the durability of the tires in spite of the constant impact and friction with the rocky surface. Then and there was born the idea of a rubber mill-lining. If a good grade of soft rubber could resist the wear of the road, was it not the ideal material to resist the wear of the grinding medium in a tube or ball mill?

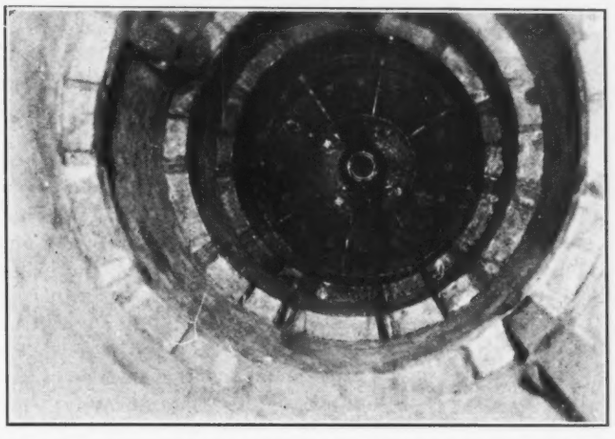
Here was the point of departure. However, various other factors had to be considered carefully. The vital question was the effect upon grinding capacity. It was assumed that it ought to be increased *if* nearly all of the grinding is accomplished within the mass of the charge and not against the liners. It was believed that the balls would indent the rubber, that the dead zone caused by slippage would thereby be reduced, and that more balls consequently would be put to work. How sound this conclusion was will appear presently.

The first actual experiment was started soon after July 16, 1921. A specially prepared slab of smooth rubber, equivalent in softness and quality to the material of which the tread of a good cord tire is made, was obtained. It was $\frac{5}{8}$ in. thick and was just large enough to line a small test mill 3 ft. long and 18 in. in diameter. Parallel tests were run with a similar mill lined with smooth iron, both being charged with 200 lb. of 2-in. iron balls, and fed with a 4-mesh battery product from which the minus-200-mesh material had been separated by screening.

The results of these tests seemed so favorable with respect to wear of the rubber and capacity of grinding that a slab of similar rubber 3 ft. wide and 13 ft. long was ordered. This was used to form a complete ring of lining in a 20 by 4-ft. mill used regularly in the Nipissing plant to regrind the sand in the overflow from the primary tube-mill circuit. About 80 per cent of the feed was minus 200 mesh and the remainder ranged up to 60 mesh. The discharge was virtually all minus 200 mesh. The rubber-lined section started at a point 28 in. from the feed end of the mill, one ring of iron lining being left to cover the section next the end. To reinforce the rubber the manufacturer had inserted two plies of canvas just beneath one face, a thin film of rubber being left to protect the fabric. This face, of course, was placed next to the shell of the mill.

The mill was operated for three months under normal conditions. At the end of that period the rubber was removed and weighed. It was found that less than $3\frac{1}{2}$ lb. of rubber had been worn away!

This was so encouraging that enough special rubber was obtained to line the entire 4 by 20-ft. mill, exclusive of the ends. On Jan. 1, 1923, this newly-lined mill was placed in commission with a charge of 20 tons of $1\frac{1}{4}$-in. white chilled iron balls. It has been in steady operation



Interior of a rubber-lined 4 by 20-ft. tube mill at the Nipissing mill. The iron "holders" may be seen encircling the interior of the mill. In the next mill to be lined with rubber three or four longitudinal strips will be used instead of rings. The end is not rubber lined.

since, and early in August when I was at the plant the lining was still in first-class condition. During this time numerous tests have been run to determine as far as possible just what the effect of the rubber lining is. Since it was impossible to run parallel tests, comparison with results obtained previously in the same mill when it was equipped with smooth iron liners must be made in two instances.

These tests were made with the utmost care, and although neither Mr. Denny nor R. B. Watson,[1] general manager of the Nipissing company, cares to publish the detailed results now, they have permitted me to study them and to draw some general conclusions, which I give herewith.

In explanation I may say that the normal flow in the plant prior to Jan. 1, 1923, was as follows: 40 stamps

[1]Patents have been granted to Messrs. Denny and Watson in Canada, United States and Mexico covering this invention. Patent applications for other countries are pending.

crushing through 4-mesh screens; primary grinding in three 20 by 6-ft. tube mills, 26 r.p.m., grinding with 16 tons of 3 and 4 in. flint pebbles on 2-in. smooth iron liners, mills loaded 2 in. above the center and operating in closed circuit with 4-ft. 6-in. Dorr classifiers; regrinding sand from primary classifier overflow in one 20 by 4-ft. tube mill, 32 r.p.m., grinding with 20 tons of 1¼-in. iron balls on ½-in. smooth iron liners (they had worn very thin), loaded to 2 in. above the center and operating in closed circuit with two 15-ft. Dorr bowl classifiers; consistency of tube mill pulp, 44 per cent moisture. The tests demonstrated the following:

(1) That the change from ½-in. smooth iron lining to ⅝-in. rubber lining increased the capacity of the mill to make slime by at least 15 per cent.

(2) That it was possible to cut out one of the three primary grinding mills entirely after the regrinding mill had been lined with rubber. This was proved by a thirty-day run. When the same thing had been tried formerly the mill soon became overloaded.

(3) That the 4 by 20-ft. mill charged with iron balls and rubber lined, produced 11 per cent more minus-200-mesh material than a 6 by 20-ft. mill charged with pebbles and iron lined. The test was run on 4-mesh battery product divided equally between the mills.

(4) That the capacity of the rubber-lined mill on 4-mesh feed is unusually high.

(5) That when the speed of the rubber-lined mill is reduced from 32 to 28½ r.p.m. it can still handle the product of 40 stamps with the aid of two primary grinders. This indicates the possibility of a further saving of power.

The question arose as to the suitability of the rubber liner on a coarser feed. Accordingly a mill in another plant at Cobalt which normally takes material that has passed a 1-in. trommel was lined with rubber. The grinding medium is 4-in. iron balls. The increased capacity of the mill was phenomenal, but unfortunately the rubber supplied was not equal in quality to the previous lots. It was somewhat harder and the vulcanizing was apparently not so good, for small scales began to crack from the surface. The manufacturers had failed to follow instructions; they thought that they knew the characteristics that were most desirable, but they were mistaken. At present a new supply of better rubber is being made for the purpose of running further tests. Mr. Denny is of the opinion that rubber can be made of such quality that it will readily stand up under the most severe wear that any coarse product will exert on it. Whether the cost will be so high as to offset the advantages remains to be determined, but it seems unreasonable to conclude that it will.

As to grinding 4-mesh and finer material, Mr. Denny does not hesitate to express the opinion positively that the use of a rubber lining will effect decided economies. Whether it will prove best to make the liner an inch or more thick instead of ⅝ in., as used thus far, is a detail still to be worked out. Perhaps additional plies of fabric to reinforce the back will be found desirable. The design of the "holder" to keep the rubber in place may be improved upon. The lining of the next mill to be equipped with rubber will consist of three or four sheets the same length as the mill, with the holders running lengthwise instead of circling the mill.

The work done so far strongly substantiates the theory that, when properly operated, a very small proportion of the grinding is accomplished by the action between the lining and the balls. Only recently has this doctrine been emphasized, but that it is entirely sound seems clear when the performance of the balls is studied.

What is the reason for the increased capacity obtained by the use of the soft rubber lining? Simply this: the balls indent the surface of the lining slightly, so that they are raised as the shell revolves without any appreciable slippage, or at least with greatly lessened slippage as compared with that which accompanies the use of iron liners. This effects a nearer approach to maximum grinding efficiency for every ball in the mill.

Following is a summary of the conclusions reached from the work done to date:

(1) The cost of the material in a new set of ⅝-in. rubber liners is somewhat less than that of a set made of iron 2 in. thick.

(2) The weight of a set of rubber liners is about $\frac{1}{10}$ that of a new set made of iron. This would be a decided advantage where freight rates are high.

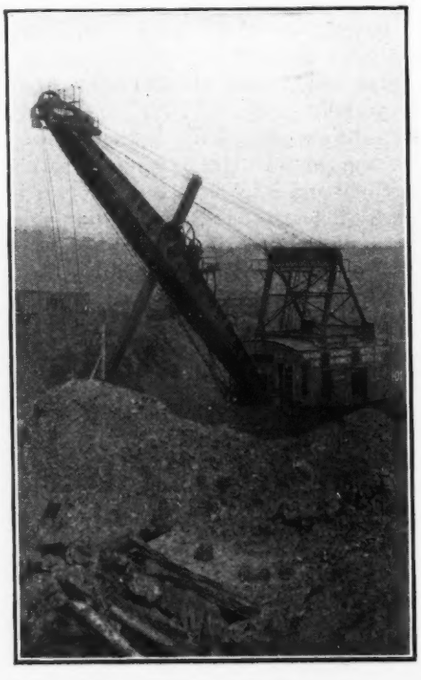
(3) The life of a set of rubber liners will, of course, depend on the thickness. However, it is safe to say that a ⅝-in. rubber liner on material under 4 mesh will last at least as long and probably much longer than a 2-in. iron liner. On this basis the cost per ton of ore crushed would be appreciably less than for iron.

(4) The mechanical work of installing or replacing rubber liners is trifling compared with the same cost for iron. The time required for replacement would be shorter, thereby reducing the period of shutdown for renewals.

(5) A rubber-lined mill operating at capacity will require slightly more power than the same mill lined with iron, for the reason that the balls are raised higher. However, the consumption of power per unit of effective crushing done will be much less.

(6) The ball consumption is less with rubber than with iron liners because the wasteful wear between balls and liners is eliminated.

(7) The grinding capacity of mill lined with rubber is much greater than that of the same mill lined with iron. That means economy in initial investment for equipment, in mill space, in operating and maintenance expenditure. It means decreased cost per unit of effective work done.



A rival of the steam shovel

No. 300 electric shovel loading iron ore at Hibbing, Minn. Many engineers freely predict that the days of the steam shovel on the Mesabi are numbered.

How to Select Prospecting Equipment

Only the Best and Most Efficient Machinery Should Be Chosen, and from Well-established Firms—Standardization Is Important

By George J. Young
Associate Editor

ALTHOUGH there are frequent instances of the careful selection of equipment for prospecting and exploration purposes, haphazard buying and careless installation are handicaps that the prospector has to live down at increased expense for operation and low efficiency.

The best quality of tools and equipment is necessary, as delays must be minimized and repairs are frequently impracticable or difficult and costly to accomplish. Time represents money outgo, and unless it is represented in useful performance there is a waste that may assume relatively large proportions. Appliances requiring a minimum of manual effort are essential. Roller-bearing cars cost only $12 more per car than those with plain bearings. In a year's time the saving in manual effort may be many times this small sum. Standardized equipment or equipment that has stood the test of extensive use affords the advantage of easily securing repair parts that can be used. Light but strong and well-designed equipment is preferable to the heavy equipment that is used in mines of large production.

ONLY the best and most efficient machinery should be selected for exploration work. This means the purchase of equipment which has been developed until it has become practically standardized. For such machinery repair parts can be readily obtained. Machinery should be purchased from long-established firms, as these maintain a service that will be of value in emergencies and their experience and business reputation are a reasonable guarantee of high quality and proved merit. The exploration plant should be reasonably free from mechanical troubles so that it will operate over comparatively long intervals without repairs. In the long run good machinery, even at a higher price, will be better than cheap machinery which leaves a trail of grief and eats up the operating capital.

In small operations one man may be called upon to do a variety of tasks during the working day, and it is for this reason that his time should be conserved to the utmost. One factor is to have the plant concentrated so as to require the minimum distance between jobs and a maximum utilization of the workmen's time. A water supply and comfortable living conveniences contribute to efficiency. The exercise of care in constructing a camp is well worth while. Equally necessary are road connections.

Tunnels and Shafts Develop Prospects

Exploration operations fall into two simple classes, one of which entails the opening up of a suspected deposit by means of a shaft or incline and the other by means of an adit or tunnel. The former requires a more elaborate equipment; for the latter a primitive equipment may suffice.

The hand windlass and rawhide bucket and hand drilling are largely of historic interest, although they are used even now in some cases. Drilling by compressed air and hoisting, pumping, and ventilation by power-driven appliances have superseded them. The auto truck has simplified transportation.

Buildings are usually constructed of corrugated galvanized iron upon a light timber framework. They entail no special difficulty and will not therefore be discussed.

The primary function of the initial plant is to provide facilities for the excavation of rock and its convenient handling, which includes loading, hoisting, transportation over relatively short horizontal distances, and dumping. It is a prime essential that these facilities shall be such that there will be a minimum of manual effort in all operations connected with the excavation and handling of the rock. This presupposes power drilling and blasting and a minimum of pick work. Loading is necessarily done by hand, as the quantities handled are relatively small and the initial cost of the equipment must be kept as low as possible. Table I has been computed to give an idea of the quantities involved. It will be necessary to add the volume of development given in the third column of the table to the volume of the dead work necessary to connect the development contiguous to the block of ore. The volume of 100 ft. of shaft, two compartments, a ladderway 3 by 4.5 ft. and a hoisting compartment 4.5 by 4.5 ft. in dimensions, is about 7,500 cu.ft., or 75 cu.ft. per foot of depth. The minimum development for 100 ft. of depth and an ore block 100x100 ft. would be 23,600 cu.ft. or about 1,850 tons. To develop an ore block 100 ft. in depth and 400 ft. in length would require a minimum of 55,100 cu.ft., or 4,250 tons. Thus the quantity range for 100 ft. of depth under the foregoing conditions will be from 2,000 to 5,000 tons.

Table I—Estimated Quantities for Development Work

Block Size, Feet	Feet Development	Cubic Feet of Development	Tons of Ore Developed Thickness of Orebody in Feet 1	5	10	20
100 by 100	460	16,100	800	4,000	8,000	16,000
100 by 200	760	26,600	1,600	8,000	16,000	32,000
100 by 300	1,060	37,100	2,308	11,540	24,000	48,000
100 by 400	1,360	47,600	3,076	15,380	30,760	61,520

In hard rock approximately 4.5 ft. of drilling would be required per ton of rock broken; the drill footage would approximate from 9,000 ft. for the 100-ft. block to 22,500 ft. for the 400-ft. block; the drill shifts corresponding would be 200 and 500, and the shoveling or loading shifts, as a rough estimate, would be 250 and 600; total drilling and mucking shifts, 450 and 1,100. These are merely estimates given to establish in a general way the quantities involved. Based on two shifts' operation per day and one drill in operation, the

days required would be 250 and 550 respectively; with two drills in operation this time could be materially reduced but not proportionally. As the estimates are given for hard rock, it is to be expected that less drilling and greater speed would be made in more favorable rock.

The crux of the situation is the efficient disposition of a certain volume of excavation. Each cubic foot represents a fixed proportion of time and of labor effort as well as expense for power and the necessary supplies. To make this amount of excavation effective it is necessary that the structure of the vein or deposit be thoroughly and accurately appreciated by the man in charge. This necessitates sufficient preliminary work upon the surface in stripping off covering and in making trenches to expose the position, width, dip, and course of the vein or deposit before sinking or tunneling is attempted. In the work a judicious use of explosives will reduce the amount of shoveling and movement of rock to a minimum.

Geology Should Be Studied

Wherever it is possible, a geological study of the situation should follow the preliminary surface work. Systematic sampling is also essential. Where it is impracticable to have assays made, panning and the careful examination of the concentrates obtained should at least be done and significant samples should be taken for assays and analyses. Structural geologic features should also be observed. The purpose of this preliminary work is to afford information to the prospector, or other person in charge, by which he may determine whether the discovery is of sufficient importance to warrant exploration, and, if so, to plan the proposed work intelligently, to the end that a maximum of result will be obtained for a minimum of expenditure.

The situations which arise are relatively few. The most obvious is where an actual outcrop has been discovered. Depending upon the topography, the exploration work, after exhausting the possibilities of surface work, may consist of a tunnel (either crosscut or drift) or a shaft, which should be sunk in the vein or deposit. Tunnel exploration requires the minimum of equipment; shaft sinking may involve the maximum of equipment, as it may be not only necessary to provide for hoisting but also for power, ventilation, and pumping. The second situation, in a general way, covers all other cases. This is where the deposit is blind or has no surface showings. Prospectors and mining men are frequently led to surmise the existence of an ore deposit by studying ore occurrences in neighboring mines contiguous to the suspected area. By prolonging the strike of a vein or by noting certain formations and their extensions, sufficient justification can sometimes be obtained to warrant the sinking of a shaft and prospecting by systematic crosscutting. Striking instances of the success of this procedure are not wanting.

Certain types of deposits, iron ore, copper ore, and flat or low dip veins, admit of the use of the churn drill and also the diamond drill as more rapid and, in most instances, less costly methods than shaft sinking for the preliminary exploration of the area at depth.

The power question is greatly simplified where operations are in a district supplied with power by a central power plant or where hydro-electric power is available. Under such circumstances a power line is constructed to the scene of operations and step-down transformers are installed. A motor-driven hoist, a motor-driven air compressor, and a ventilating fan driven by a separate motor, or by means of a belt from the compressor, comprise the essential elements. The features of these three motors and their approximate cost are given in Table II.

Table II—Motor Equipment Required for Shaft Exploration

Motor	Horse-power	Speed, R.P.M.	Weight, Pounds	Approximate, F.O.B. Cost
Hoist, variable speed motor, including continuous duty resistor	20	.....	1,250	$500
Compressor	75	1,200	2,300	700
Ventilating fan	5	1,800	250	125
Totals	100		3,800	$1,325

The compressor motor is larger than necessary and could therefore carry the small power requirements of the ventilating fan. This would reduce the motor horsepower to 95, the total weight to 3,550 lb., and the cost to $1,200. A separate motor for the ventilating fan is preferable, although not absolutely necessary. For drilling purposes the compressor would be operated about twelve hours per day, which would permit the operation of a pump during the remainder of the day.

In the absence of power from a central source, several arrangements are practicable. The simplest arrangement is to operate the hoist and the pump, as well as drills, by compressed air. It is not necessary to provide compressed air for the operation of drills, hoist and pump simultaneously, for while the drills are in operation both pump and hoist can be shut down. By providing additional receiver capacity, incidental trips can be taken with the hoist without interfering with drilling. Thus the power unit will consist of an air compressor driven by an internal-combustion engine or a steam engine.

Where local fuel is abundant and cheaply obtained, the steam engine is a convenient power agent. Under such circumstances hoisting can best be done by means of a steam hoisting engine. In most situations steam power is objectionable for a variety of reasons, chiefly, however, on account of the cost and difficulty of providing fuel and a suitable water for boiler purposes. The steam installation has important advantages where it is applicable.

Gas Engines Have a Place

In isolated situations where fuel must be transported and is relatively high in cost, the internal-combustion engine has the important advantage of utilizing the least weight of fuel per horsepower-hour. Gasoline, distillate, and crude-oil engines have been used for prospecting purposes. Of the three types of internal-combustion engines, the Diesel, or crude-oil engine, is the most economical in fuel consumption, the gasoline engine the least. The power arrangement which represents the greatest simplicity is an air compressor of sufficient capacity to provide for both hoisting and drilling and driven by a Diesel or some of the modifications of this type which approach the full Diesel in fuel economy.

The full Diesel will operate on about 0.5 lb. of 13 to 26 gravity oil per horsepower-hour. A 100-hp. Diesel can be operated on 6.8 gallons or 50 lb. of crude oil per hour. The fuel requirements per day will range from 50 to 100 gal. or from 400 to 750 lb. per day. The monthly fuel requirement would range from 1,500 to 3,000 gal. At 5c. per gallon, the fuel cost would range from $75 to $150 per month. For two shifts' operation per day, the operating cost of a 100-hp. power unit,

including fuel, attendance, and lubricants, would range from $390 to $475 per month. The cost of such a unit erected would range from $7,500 to $10,000. This includes a fuel tank. A 75-hp. engine would cost from $6,500 to $8,300. The figures given are approximate, only, but include freight, erection, and fuel tank. The range in cost depends upon the make of engine selected. One manufacturer quotes his f.o.b. cost at $60 per horsepower for a 100-hp. engine and another quotes $85 per horsepower for the same sized engine. Allowing a 50 per cent salvage value, the initial cost for two years' service ranges from $78 to $104 per month for a 100-hp. engine. This would bring the total monthly power cost up from $468 to $579. The question of weight is of importance. One manufacturer gives the shipping weight of a 100-hp. engine as 24,600 lb.; another gives the weight for a full-Diesel engine of the same power as 20,000 lb.; for a 75-hp. engine the shipping weight is given as about 18,000 lb. and for the full-Diesel, 17,500 lb. Engines can be stripped; the heaviest part is the bedplate. Where access is afforded by a road, there is little difficulty in transporting these engines, but where packing is necessary, the installation of engines of this type is difficult. Sectionalized construction would meet the difficulty, but so far as my information goes sectionalized construction has not been attempted. It is practicable but costly.

THE basis of successful exploration is intelligent digging. To do this efficiently and rapidly necessitates a well-selected plant that can be readily assembled and put in operation. Where negligible results are obtained the prospecting equipment should be dismantled and moved to new ground. The plant should be designed to readily meet the conditions imposed by repeated dismantling and re-erection.

An alternative power arrangement would be a Diesel engine direct-connected to a generator and the use of motors for compressor, hoist, and other purposes. For the prospect this arrangement would be more complicated and would be therefore disadvantageous. For the small mine operating a milling plant the arrangement suggested would have important advantages.

Other arrangements in use comprise a gasoline or distillate engine driven hoist and a distillate engine for the operation of the compressor. This is favored by many, but is less simple than the single engine arrangement suggested in the foregoing. The steam plant has been mentioned. An alternative arrangement would be a steam turbine direct-connected to a generator and the use of motors for the driving of separate units. This would not be especially satisfactory for the prospect, although it would be worth consideration for the small mine equipped with a milling plant.

A power unit consisting of a water wheel connected to an air compressor, or to a generator, and providing for the use of power either by compressed air or by electricity, would be considered where water power is available at not too prohibitive a cost for development. Where water is available under considerable head it would seem to me that the simplest arrangement would be the hydraulic air compressor and the use of compressed air for all power purposes. This method only requires several pipes and a receiver for the air compression. It would be practically automatic in its operation and need little attention. The situations where conditions are favorable for the use of this arrangement are few and far between.

The minimum equipment for drilling purposes is assumed to be two drills, both of the same type and size. The hand-held or "jackhammer" type is probably the kind used most for prospecting purposes. The drill should weigh from 45 to 50 lb. One mounting, together with a 3-in. bar, arm, and clamp, should be provided. One drill should be of the water type for drifting. Where raises are to be driven, an additional drill of the stoper type would be an advantage. This should be a medium weight drill and provided with a water attachment. All of the drills should be fitted for $\frac{7}{8}$-in. hollow hexagon steel. Ten sets of steel should be provided. Two 50-ft. lengths of $\frac{3}{4}$-in. air drill hose and the necessary water hose and tank for the water drill should also be provided. The cost of this equipment, omitting the stoper, approximates $850. The equipment will give two drills for shaft sinking, and both drills can be used in drifting and crosscutting. The mounted drill could be used for both drifting and raising. Both drills in operation will require about 150 cu.ft. of free air per minute when in good mechanical and operating condition.

A drill sharpener is included. Preferably one of the smaller sizes should be installed. With accessories and an oil-fired forge the cost of the equipment may exceed $1,000. Some may consider a sharpener unnecessary, but when the problem is analyzed the drill sharpener can be shown to result in a decided saving. Rock drills can be sharpened by hand and all of the necessary work except shanking accomplished. I am informed that where a drill sharpener is not used drills must be sent to manufacturers' service stations and shanked at a charge of 75c. per drill. Freight to and from the service station would increase this charge to a measurable extent. The tool sharpening required would amount to from 80 to 100 drills per day. This could be done in less than two hours' time with a sharpener and better drills turned out. By hand it would require a blacksmith and helper the greater part of a day. The comparative labor cost would be $2 and $10 respectively. The drill sharpener would save its cost in one year's operation.

In many prospecting installations a 9x8-in. single-stage, belt-driven compressor is installed. This compressor is rated at 145 cu.ft. piston displacement and requires 24 b.hp. for its operation, and air at 100 lb. pressure. This would be just sufficient for two drills operating simultaneously. Many operators get by with this arrangement, but at the sacrifice of more or less efficiency. To provide compressed air for hoisting and for pumping as well it is suggested that a 12x10 short-belt drive compressor be installed. This compressor is rated at 355 cu.ft. piston displacement at 275 r.p.m. and requires 65 b.hp. for air at 100-lb. pressure. The approximate cost of this size, including short belt drive, belt, foundation bolts, and a 56 cu.ft. receiver, is $1,500. By scheduling compressed air service this compressor would provide sufficient air for hoisting and pumping a moderate amount of water. It would also provide for an increased consumption of air when drills become

worn and the other air-driven machinery deteriorates.

The market affords many well-designed compressed-air hoists. The development of the stretcher-bar hoist and scraper hoists has resulted in a variety of types. One of the smallest of these hoists weighs somewhat less than 300 lb. and will lift 1,000 lb. at 85 ft. per minute with an air consumption of about 100 cu.ft. per minute. Another and heavier design weighs 600 lb. and will lift 1,500 lb. at a speed of 110 ft. per minute with an air consumption of about 150 cu.ft. per minute. The cost of the two hoists is respectively $350 and $600. Hoists of heavier construction and especially designed for shaft service are available upon the market. The cost of the hoist, rope, and accessories will range from $500 to $1,000.

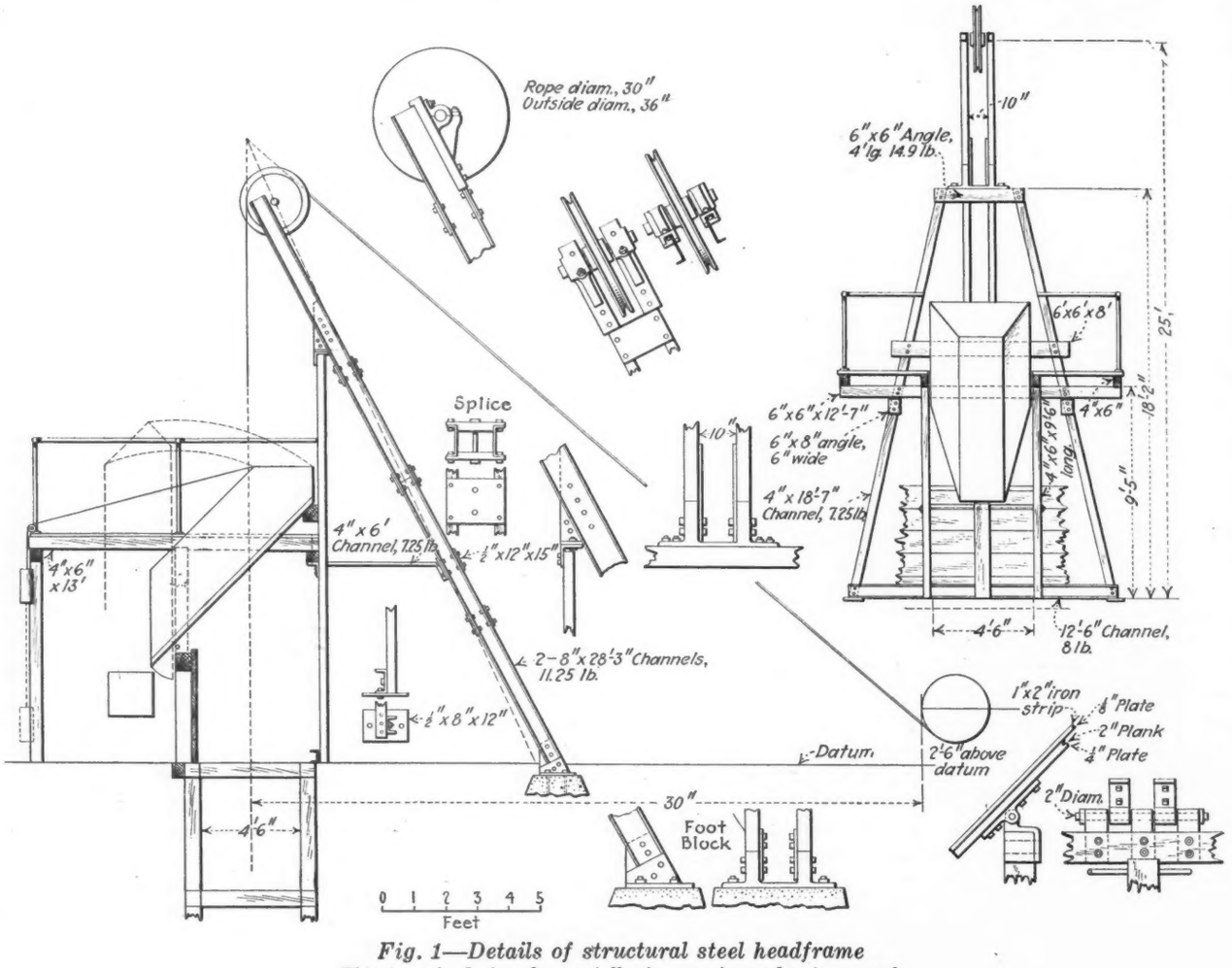


Fig. 1—Details of structural steel headframe
This type is designed especially for use in exploratory work

A simple type of headframe suitable for exploration work is shown in Fig. 1. Two designs are shown; in one structural steel is indicated and in the other timber, Fig. 2. It is interesting to note that no attempt has been made to standardize prospecting headframes, in spite of the fact that when excitement rages in a new district many prospecting plants are erected and a great variety of types and sizes of headframes. Nevertheless, they are all erected to serve a similar purpose. An easily erected simple type that could be dismantled and used upon another prospect seems to be needed and apparently only lack of enterprise has prevented machinery men from developing, manufacturing and selling a standardized structure. The design shown can be readily adapted for cage hoisting. The height can be increased to 30 or 35 ft. if it is considered necessary.

Three types of bucket dumps are shown for vertical shafts, Fig. 3. One is the common ball and chain dump (*A*) which is used with a swinging apron, and the other (*B*) is an original design submitted for discussion. The bucket dump shown consists of a basket which is pivoted off center and which is retained in upright position by a counterweight and brake. The lowering of the bucket overturns the basket and dumps the bucket.

The third design (*C*) is taken from "Practical Details of Mining," and is a device that was used for bucket dumping by the Kennedy mine in shaft-sinking work. The arrangement consists of a heavy ring bolted five or six inches below the bottom of the bucket. The ring engages with a heavy hook and the weight of the bucket throws it into the dumping position. Automatic bucket dumps have the advantage of saving labor at the surface.

Where pumping is required the small compressed-air driven sinker is as convenient a device as can be found. The smallest pump of this type weighs 800 lb. and costs with suction hose and footpiece about $300. To lift 27 gal. per minute 100 ft. requires 40 cu.ft. of free air per minute; for 350-ft. lift, 104 cu.ft. per minute. Small quantities of water can be handled by means of a bailer.

The ventilating requirements of a prospect are easily handled by a small blower. The most suitable size is one provided with a 9-in. discharge opening. This

blower at 1,800 r.p.m. will supply 1,740 cu.ft. of air at one inch water gage and a power input of slightly less than two horsepower. The cost of the fan is nominal, about $70. The cost of air pipe is nominal.

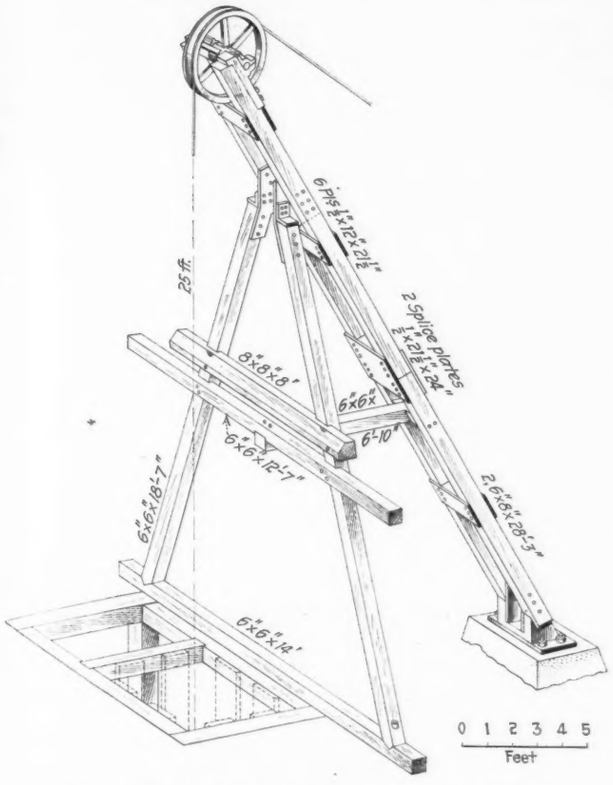


Fig. 2—Details of simple wooden headframe

Where a less costly type than steel is desired this one will prove adequate

The approximate total cost of the plant suggested is given in Table III.

Table III—Estimated Cost for Shaft Equipment

	Cost	Weight, Pounds
1 75-hp. Diesel engine	$6,800	14,000
2 jackhammer drills, both 45 lb. weight, one water type	370	
1 mounting, bar, arm and clamp	160	800
Water hose, drill hose, tank and accessories	80	
10 sets drill steel	200	
1 drill sharpener, furnace and accessories	1,000	1,000
1 12 x 10 compressor, short belt drive, belt, receiver and foundation bolts	1,500	5,800
1 hoist, air-driven	500	1,500
1 24 x 30 in. bucket (*a*)	35	141
500 ft. ¾-in. hoisting rope and attachments	75	175
Sinking pump, suction hose and foot valve	300	900
1 9-in. blower and air pipe	200	200
2 16 cu.ft. ore cars, roller bearing	212	1,300
200 ft. track, 8-lb. rails, ties and incidentals	75	1,600
Headframe (wooden)	500	3,500
	$12,007	30,916

(*a*) Two buckets enable a fuller use of time in mucking.

Substitution of a motor for the 75-hp. Diesel engine would reduce the cost by $6,100. The estimated cost given in the table covers only the important items. Pipe, fuel storage, miscellaneous tools, housing, freight and transportation are not considered. Including an $850 truck (the cheapest one-ton auto truck weighs 1,427 lb. and costs $543; a rubber tired tractor of well-known type sells for $776), the total cost can be roughly estimated at $16,000.

The equipment suggested in Table III is sufficient for bucket hoisting, but would not be heavy enough for cage hoisting. The minimum weight to be hoisted by a single-deck cage would be 3,500 lb. (single-deck cage 800 lb., ore car 650 lb., ore 1,600 lb., 500 ft. ⅝-in. rope 280 lb.). To lift this weight at a speed of 200 ft. per minute would require theoretically 21.2 hp.; at 80 per cent mechanical efficiency the power requirement would be 26.5 hp. A motor-driven, single-drum hoist, 35 hp., would weigh 6,000 lb. and cost about $2,300. A 35-hp. gasoline hoist would weigh 6,500 lb. and cost about $2,100. Either unit would be suitable for the load and speed given. By the substitution of one or the other, depending on the kind of power most suitable, cage operation to a depth of 500 ft. could be accomplished. The total cost in Table III would be increased by $1,800 and the weight by 5,800 lb., the totals becoming $13,807 and 36,716 lb. respectively. If the compressor indicated in Table III is retained, its capacity would be sufficient for four small drills or two drills per shift and the operation of a small air-driven pump. The substitution of a two-drill compressor, complete with air receiver and fittings, at a cost of $1,200, would make a saving in the total of $300.

The substitution of the heavier hoist required for cage hoisting can be avoided by the arrangement shown in Fig. 4. The rope pull and hoisting speed are reduced to one-half of that required by the single-rope arrangement. The arrangement is effective. An 18-in.

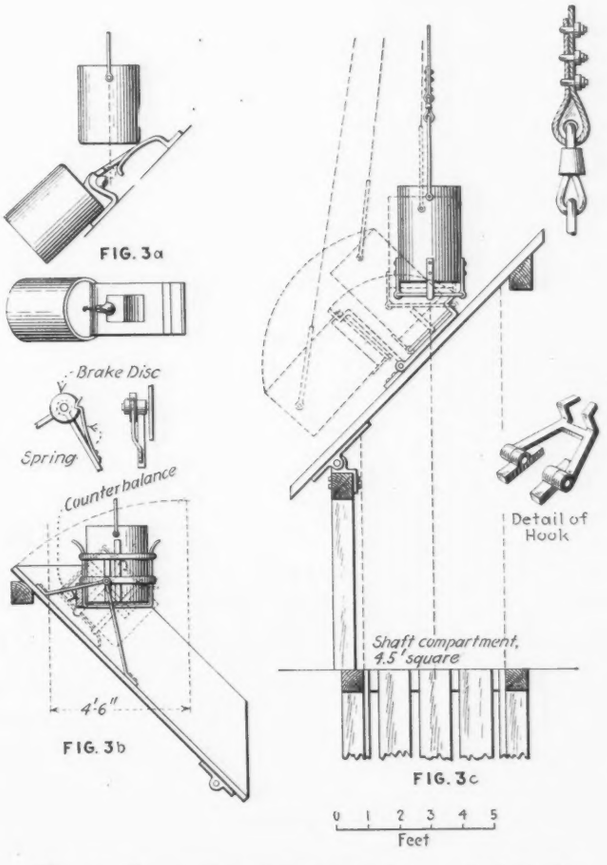


Fig. 3—Types of bucket dumps for vertical shafts

Fig. 3b is a suggested design but has not been tried out

sheave would be required for attaching the rope to the cage.

An alternative arrangement is shown in Fig. 5. This requires the use of a double-drum hoist, two ropes, and a counterbalance equal to the weight of the cage and car. By the use of the arrangement the rope pull is

diminished by the weight of the counterbalance, but the speed of hoisting remains the same.

The minimum cost plant is a subject of interest to the prospector, who frequently cannot command the capital necessary to embark upon a campaign such as has been suggested in the foregoing. The market affords small machines in considerable variety. In addition the second-hand machinery market also presents possibilities, although all of such machines should be thoroughly overhauled and put in good operating condition before they are used. The equipment for a one drill outfit for shaft prospecting is suggested in Table IV.

Tunnel Prospecting Obviates Hoisting Expense

For tunnel prospecting the cost is reduced by the amount provided for hoisting facilities. This will bring the cost to $2,620. The minimum number of men for either shaft or tunnel prospect would be three. A one-ton truck ($850) would increase both amounts to $4,395 and $3,470 respectively.

The substitution of a Little Tugger hoist for the gasoline hoist and a larger compressor for supplying

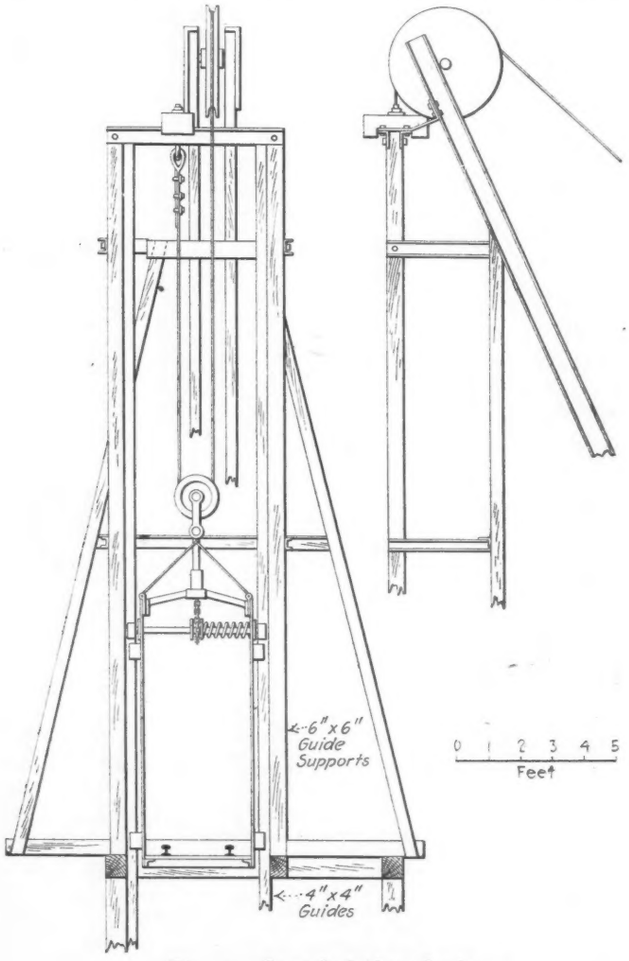


Fig. 4—Cage-hoisting device

It allows a smaller hoist to be used but decreases the speed of hoisting

both the drill and the hoist results in the estimate of cost given in Table V.

This table would indicate that the arrangement would increase the cost appreciably, although there might be a small gain in operating expense. The substitution of a horsepower hoist would bring the former estimate to about $3,000, which would be the minimum f.o.b. cost of a one-drill plant equipped with hoisting facilities.

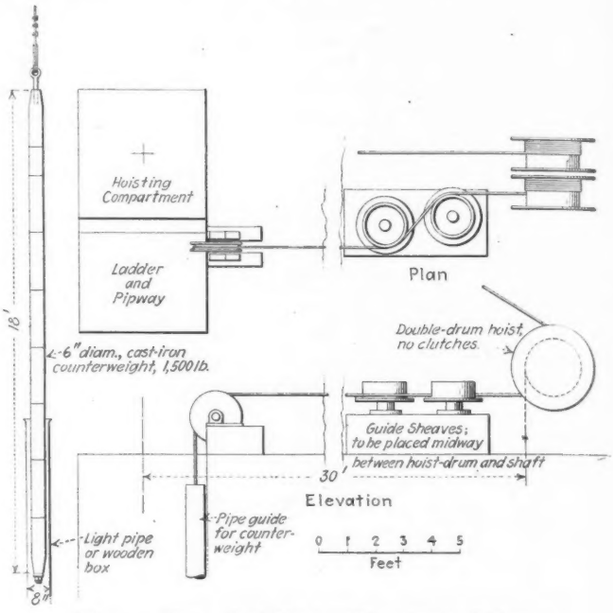


Fig. 5—Cage hoisting with counterbalance

For hand drilling, the necessary requirements for shaft work are given in Table VI.

Table IV—Minimum Cost Shaft Equipment

1 6-hp. gasoline or kerosene hoist; drum diameter 10 in.; drum length 10 in.; maximum load 1,025 lb.; rope speed 150 ft. per minute; size of rope ¼ in.; shipping weight 2,300 lb.	$575
1 jackhammer drill (45-50 lb. weight)	180
1 mounting, bar, arm and clamp	160
1 50-ft. length of drill hose and attachments	20
Blacksmith tools, forge, anvil and incidentals	120
5 sets of drill steel	100
1 7 x 6 compressor, short belt drive and belt, receiver	600
1 15-hp. internal-combustion engine	1,000
1 9-in. ventilating fan, belt and air pipe	150
2 mine cars, 16 cu.ft. roller bearing	215
200 ft. track 8-lb. rails, ties and incidentals	75
Headframe, rope, bucket and attachments	350
	$3,545

Table V—Cost Estimate for Shaft Exploration

1 No. 1 H Little Tugger hoist, or equivalent	$340
Bucket and rope	50
Headframe	150
1 jackhammer drill, mounting, bar and hose	360
Blacksmith tools, forge, anvil, and incidentals	120
5 sets of drill steel	100
1 9 x 8 compressor, short belt drive, and receiver	915
125-hp. internal-combustion engine	1,575
Ventilating fan and air pipe	150
2 mine cars, roller bearing and 200-ft. track	290
	$4,050

Table VI—Prospecting Equipment for Hand Drilling

1-hp. hoist	$350
Blacksmith tools and forge	80
Drill steel	50
Ventilating fan, air pipe, oil engine	300
2 mine cars, roller bearing, 200-ft. track	290
Auto truck	850
	$1,920

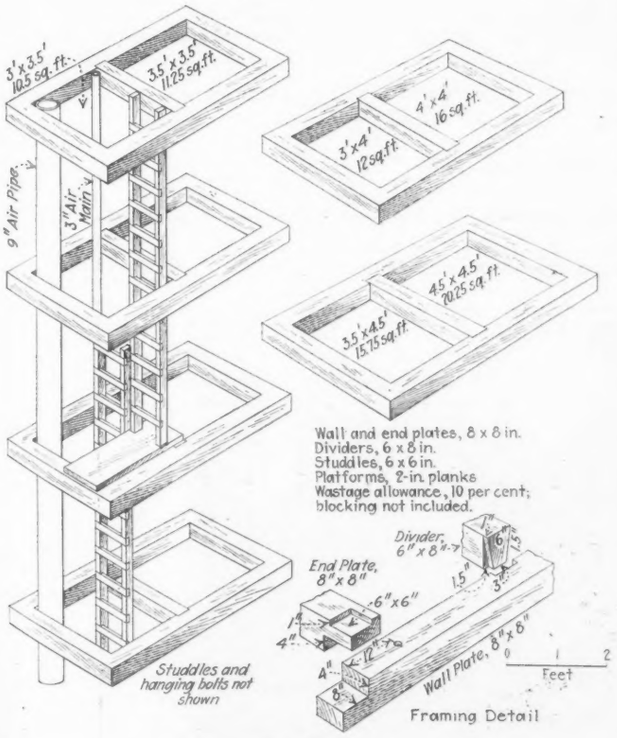
For tunnel prospecting, the cost of material is reduced to $1,570.

Prospecting operations are sometimes conducted in a desultory manner, and as a consequence there is both waste of time and effort. This is frequently the result of an inadequate plant and the requirement to "get by" through the lavish use of labor. Where a plant of the kind indicated has been installed the operations should be systematically planned. The minimum labor force

on the day shift should consist of a foreman who is in general charge, two miners, a hoisting engineer who will also operate the compressor, a general surface man who can be trained or broken in as a tool sharpener, and a general underground man who can assist in handling tools, timbering and miscellaneous work both underground and on the surface. For the second shift two miners underground and two surface men, one of whom is a hoist engineer, would suffice. This gives a total of ten men for two shifts' operation.

Method of Estimating Yearly Operating Cost

If the plant cost be assumed to be $16,000 and the salvage be estimated to be 30 per cent, the plant cost on the basis of two years' operation of 350 days per year will be $8 per shift; on the basis of one shift, the plant cost will be $16 per shift; on the basis of three shifts per day the plant cost will be $5.33 per shift. The labor cost on the basis of two shifts' operation and ten men employed may be assumed to be $60 per day. The power cost is estimated to be $8 per day. This brings a total of $84 per day for labor, power, and plant cost. The total of these three items for a campaign of 700 days is $58,800. Miscellaneous supplies, drill steel, explosives, repair parts, and incidentals may be estimated at $5,000, and the total becomes $63,800; including the salvage the total becomes $68,600. This last figure represents the initial capital resources for a two-year exploration campaign. In the case of tunnel exploration, the plant cost would approximate $10,000.


3'x3.5' 10.5 sq. ft.
3.5'x3.5' 11.25 sq. ft.
4'x4' 16 sq. ft.
3'x4' 12 sq. ft.
4.5'x4.5' 20.25 sq. ft.
3.5'x4.5' 15.75 sq. ft.
9" Air Pipe
3" Air Main
Wall and end plates, 8 x 8 in.
Dividers, 6 x 8 in.
Studdles, 6 x 6 in.
Platforms, 2-in. planks
Wastage allowance, 10 per cent; blocking not included.
Divider, 6" x 8"
End Plate, 8" x 8"
6" x 6"
Studdles and hanging bolts not shown
Wall Plate, 8" x 8"
Feet
Framing Detail

Comparative Dimensions

Hoisting Compt., Feet	Ladder Way, Feet	Outside Timbers, Feet	Dimensions Excavation, Feet	Area Excavation, Sq. Ft.	Volume Per 100 ft., Cu. ft.	Timber for 100 ft., Bd. Ft.	Lagging 100 Ft., Sq. Ft.
3.5 x 3.5	3 x 3.5	4.83 x 8.3	5.5 x 10	55	5,500	4,200	2,630
4 x 4	3 x 4	5.4 x 8.8	7 x 10.5	74	7,400	4,620	2,840
4.5 x 4.5	3.5 x 4.5	5.8 x 9.8	7.5 x 11.5	86.3	8,630	4,850	3,120

Fig. 6—Comparative shaft sizes

The largest section is preferable and can be enlarged readily

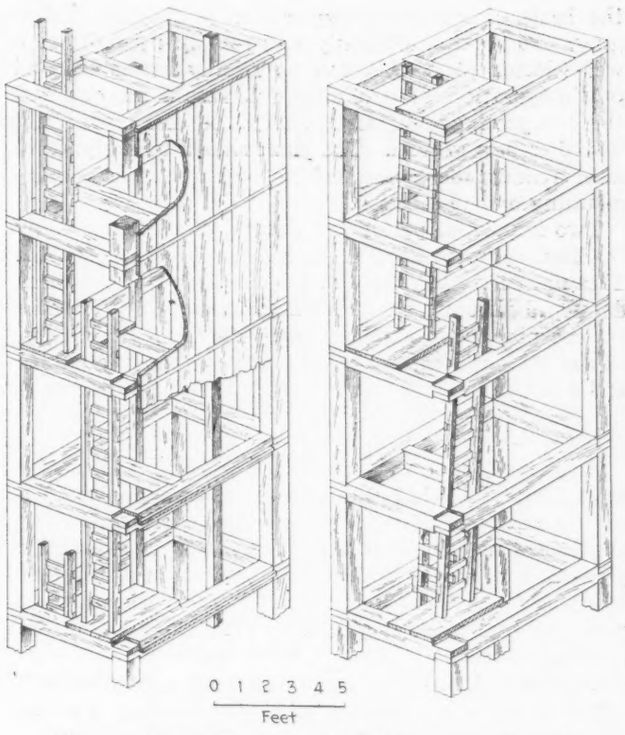


Fig. 7—Arrangements of ladder compartments

Another arrangement is shown in Fig. 6

The cost of labor, power, plant and supplies is estimated at $50,000 on the basis of two shifts' operation and eight men employed per day; including the salvage the total initial capital becomes $53,000. The initial capital estimates do not include any provision for property payments. These would be additional. In the case of shaft exploration, 7,000 labor shifts, and, in the case of tunnel exploration, 5,600 labor shifts at $6 per day, represent the expected output. For a one-year campaign the estimated initial capital requirements are $42,300 for shaft exploration and $28,600 for tunnel exploration.

For one year's operation of a plant indicated in Table VI (one drill and one shift per day), three men being employed, the operating expense for 350 days is estimated at $7,800; the capital requirement, excluding cost of buildings but including an auto truck, is estimated at $12,250. For tunnel prospecting, the capital requirement, excluding buildings but including auto truck, the estimate is $10,500. The total number of shifts in these cases is taken at 1,050 at $6 per shift. The estimates are not complete, as only the major items are included.

Prospecting Should Be on Business Basis

Prospecting is essentially a venture. It may be likened to a fishing excursion. The fisherman may put in quite a few dollars into his equipment and spend no little sum in railroad fares and then whip a stream for his entire vacation without catching a fish. However, if he studies the game and pioneers in new ground he eventually brings in a full creel. Until prospecting is organized on a business basis it will continue to be unremunerative except for the occasional lucky strike. Sometimes even the raw fisherman catches an arms-length trout in waters which have persistently failed the expert. Prospectors must keep in mind the fact that

the basis of successful exploration is intelligent digging. To do this efficiently and rapidly necessitates a well-selected plant that can be readily assembled and put in operation. Where negligible results are obtained the prospecting equipment should be dismantled and moved to new ground. The plant should be designed to meet readily the conditions imposed by repeated dismantling and re-erection.

Two important points are worthy of mention. Only the best and most efficient machinery should be selected. This means the purchase of machinery which has been developed through all of its initial stages until it has become practically standardized. For such machinery, as has been stated, repair parts can be readily obtained and a minimum of fitting and machine work is required in rehabilitating either a worn or broken machine for further use.

As a corollary to this, machinery should be purchased from long-established firms, as these firms maintain a service that will be of value in emergencies and their experience and business reputation are a reasonable guarantee of high quality and proved merit in the equipment purchased from them. The exploration plant presupposes a plant that will be reasonably free from mechanical troubles and that will operate over comparatively long intervals without repairs. An elaborate repair plant is almost impossible to provide without excessive expense, and in the long run good machinery, even at an enhanced price, will be better than cheap machinery which leaves a trail of grief and eats up the operating capital.

Employ a Competent, Experienced Crew

The second important guiding principle is in the selection of the operating crew. Experienced, all-round men are essential in operating a prospecting plant. The work is such that few specialists can be employed. Miners must be all-round men who can handle any work in mining from the timbering to the muck stick. Of most importance is the foreman. He should be experienced in shaft sinking and the routine work in mining. In the long run it pays to pay higher than the ruling wage for prospecting work, as experienced men are an insurance that machinery will be properly handled and that grief will be reduced to the minimum that is unavoidable.

Selection of Shaft Dimensions

Three shaft sections are shown in Fig. 6. The smallest section is probably too small for most operations. The largest section, hoisting compartment 4.5 ft. square, is preferable, as it can be enlarged to a three-compartment shaft without widening. A simple method for framing the timbers is indicated in Fig. 6. At least three methods for arranging the ladder compartment are possible. One is shown in Fig. 6 and the other two in Fig. 7. In working out the final details of shaft timbering and lagging details to meet the specific conditions, there is latitude for the exercise of considerable judgment. For example, the volume of excavation can be reduced by using inset lagging. The work of sinking can also be facilitated by providing two hoisting buckets and a convenient bucket attachment so that the rope can be quickly detached. Safety crossheads are well worth considering, and although they add further complication, they are an additional element of convenience and safety where they are properly designed and installed.

The incline is preferable to the vertical shaft in many situations, as by sinking on the vein the greatest amount of information can be obtained and ore can often be extracted. Headframes for inclines are as a rule of simple design, and convenient bucket and skip dumps can be readily arranged.

Prospector and Dog Team in the Northern Bush

Photo by W. Lee Heidenreich

On "Four-Mile Portage," Reed Lake, Manitoba

Efficiency and Power Requirements of Fans

A Discussion of the Effect of Various Conditions—Calculations for Determining Factors of Operation

By Walter S. Weeks
University of California, Berkeley, Calif.

IN PREVIOUS ARTICLES[1] I have shown how the operator may determine what his fans will do under most conditions encountered in practice. In this article I shall discuss the effect of various conditions on fan efficiency and power.

When a fan characteristic is determined by means of a fan test, the horsepower required to run the fan at different points on the characteristic is determined at the same time. A horsepower curve may be drawn to show the power required at all points on the characteristic.

A fan is given credit for producing static pressure and for producing velocity at the fan outlet. The static pressure is measured in inches of water, so the velocity in the air leaving the fan outlet must be converted into velocity pressure and expressed in inches of water.

If the air is leaving with a velocity of v feet per second and w is the weight of one cubic foot of air, the velocity pressure in pounds per square foot is $\frac{wv^2}{2g}$ where g is the acceleration due to gravity. This quantity divided by 5.2 gives the velocity pressure in inches of water, because a pressure of 5.2 lb. per sq.ft. is equivalent to 1 in. of water. The sum of the static and velocity pressures is the total pressure produced by the fan.

The horsepower with which the fan is credited is $\frac{PQ}{33{,}000}$ where P is the total pressure of the fan in pounds per square foot and Q is the quantity in cubic feet per minute. If the total pressure is i inches of water, then the "horsepower in the air," as it is called, would be $\frac{5.2\ iQ}{33{,}000}$.

The power required by the fan is determined by means of a dynamometer or by a motor. When a motor is used, the power input to the motor is measured and the motor losses are subtracted.

The "horsepower in the air" divided by the horsepower necessary to run the fan is the mechanical efficiency of the fan. If the efficiency is obtained at several points on the pressure-volume characteristic, a mechanical efficiency curve may be drawn as curve B, in the illustration. The curve shows the mechanical efficiency for all points on the characteristic A.

In the other articles I showed how the following calculations are made:

Given a characteristic of a certain size fan running at a given speed:

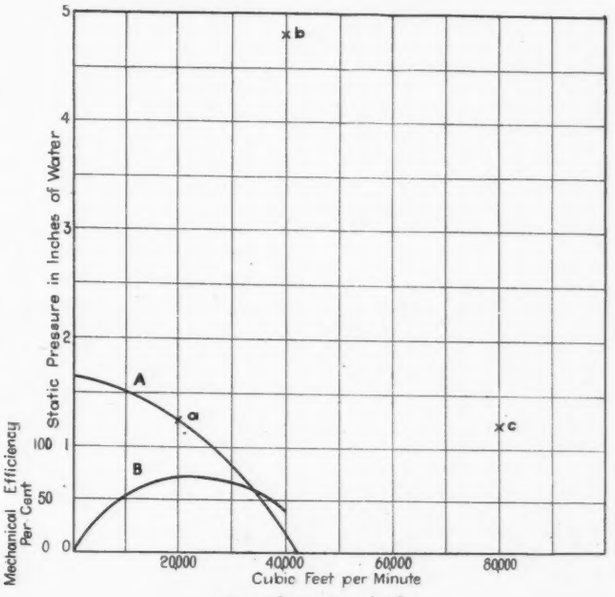
1. To calculate characteristics at different speeds.
2. To determine at what speed to run the fan to make a characteristic pass through a given point.
3. To calculate a characteristic with air of a different density.
4. To calculate a characteristic of a similar fan of different size.

Let us now consider what the efficiency and horsepower of the fan will be under the conditions of the new characteristics, assuming that we are working with the fan the curves of which are shown in the illustration.

The principle that makes easy the discussion of efficiency is the following: The efficiency of a fan remains constant as long as the ratio of static pressure to velocity pressure in the fan outlet is unchanged.

Let us now attempt to determine the efficiency under the four conditions enumerated:

1. Change of Speed.—To plot a pressure-volume characteristic at a different speed, select a point on the given characteristic and multiply the quantity by the ratio of speeds and the pressure by the square of the ratio. If we had a pipe on the fan, at these two points the gate opening would be the same. The letter a represents a point on the fan characteristic A in the illustration. Suppose the speed of the fan is doubled, then b would be the point on the new characteristic that was obtained from a. What will be the efficiency at b?



Fan characteristic

We have doubled the quantity and we have multiplied the static pressure by four. Doubling the quantity doubles the velocity. Velocity pressure varies as the square of the velocity, so we have multiplied the velocity pressure also by four. It is seen that we have multiplied both static and velocity pressure by the same factor, so we have not changed the ratio, and the efficiency at b is the same as the efficiency at a.

Since the pressure has increased four times and the quantity has been doubled and the mechanical efficiency is unchanged, the power has increased eight times. The law may be stated: With constant gate opening the power to run the fan varies as the cube of the speed ratio. It takes, then, eight times as much power to run the fan under b conditions as under a conditions.

A mine may be looked upon as a given gate opening, so that changing the speed of the fan will not change the mechanical efficiency, and volume, pressure, and power will change according to the above laws. For example, if a fan on a mine causes a pressure of 2 in. when 30,000 cu.ft. per minute are in circulation, if the

[1] "Selection of Fans for Pipe Ventilation," *Journal-Press*, May 13, 1922; "Useful Fan Calculations," *Journal-Press*, April 14, 1923; "Ventilation Problems," *Journal-Press*, Sept. 8, 1923.

speed is doubled the pressure will be 8 in. and the quantity 60,000 cu.ft. If the power in the first case is 8 hp., 64 hp. will be required when the speed is doubled. The mechanical efficiency will be unchanged.

2. To Pass a Characteristic Through a Given Point.—The calculation of the speed at which a fan should be run to give a certain quantity at a given pressure entails the determination of a point on the known characteristic where the gate opening is the same. It involves the same principles as the last problem.

3. Change of Density.—If the density of the air is changed, the static pressure varies directly with the density and the velocity pressure varies directly with the density, so change in density does not affect the ratio of static to velocity pressure and so the efficiency curve remains unchanged. If a fan is run at a given speed, then for a given quantity delivered the efficiency is the same regardless of density. The power required to run the fan at a given speed on a given gate opening or mine varies directly with the density, because total pressure varies directly with the density and power varies directly with the total pressure if mechanical efficiency and quantity remain unchanged.

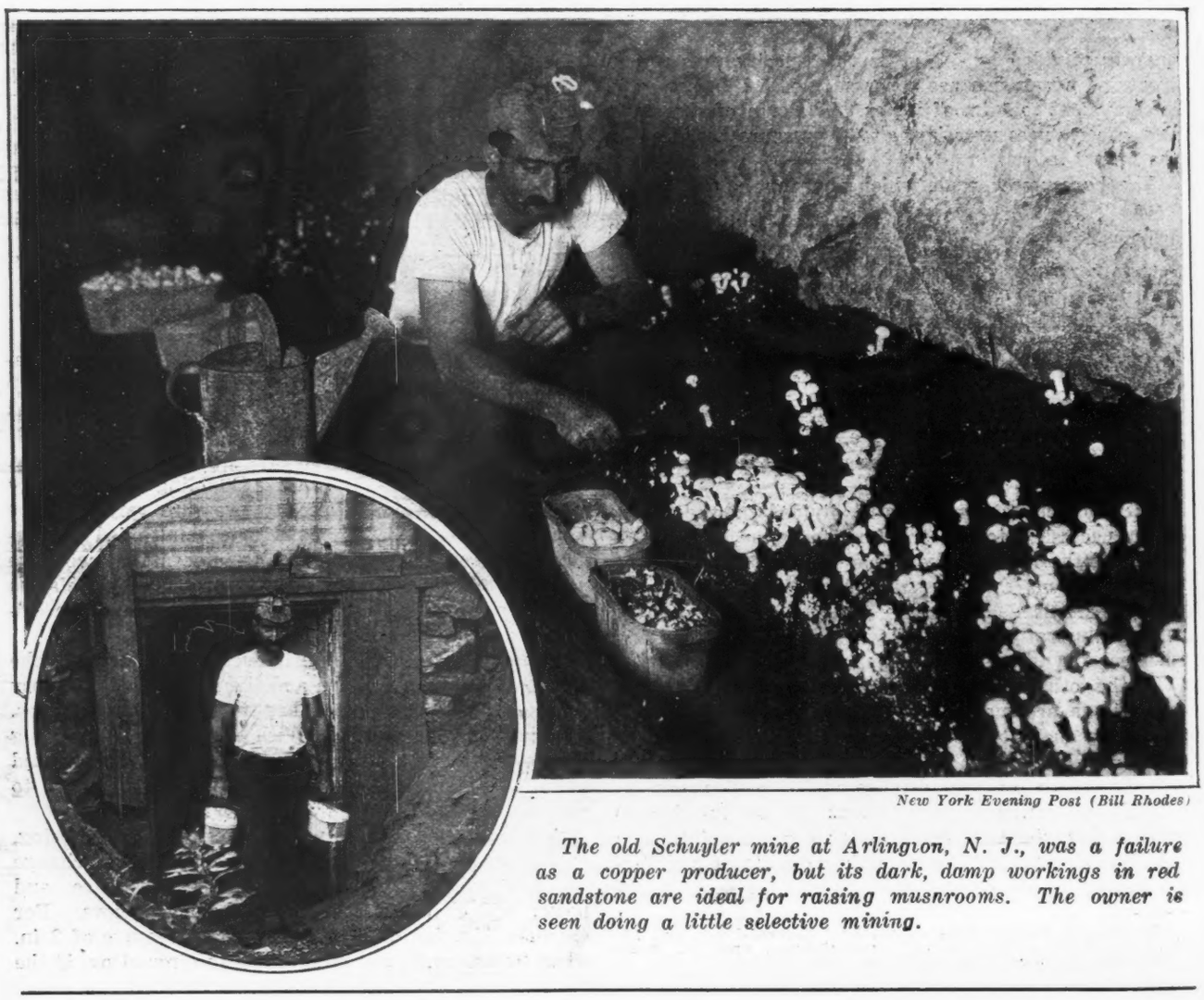
4. Similar Fans.—In calculating a characteristic of a similar fan of different size, a point on the known characteristic is selected and the quantity is multiplied by the square of the size ratio. The new point is plotted with this new quantity and the same pressure. Given characteristic *A*, in the accompanying curves, we desire to plot the characteristic for a fan twice this size. Selecting a point *a* we should obtain from it the point *c*, which is a point on the new characteristic at the same tip speed. What is the efficiency at *c*?

The quantity has increased four times, but the area of discharge has also been increased four times, so the velocity of the air leaving the fan is the same as it was in the case of the smaller fan. The static pressure is unchanged, so the efficiency is unchanged.

The air has increased four times, the pressure is the same, and the efficiency is the same, so the horsepower has increased four times, or as the square of the ratio wheel diameters.

Exhaust Fans.—A fan operating at a given speed will circulate practically the same quantity of air through a mine whether it is operating as a pressure fan or as an exhauster. The water gage on the mine, when the fan is exhausting, will be higher than when the fan is blowing, because the water gage on the exhauster records velocity pressure as well as the friction pressure. The characteristic of the fan usually can be used to give the flow of air when the fan is operating as an exhauster.

Once a Copper Mine; Now Produces Mushrooms



New York Evening Post (Bill Rhodes)

The old Schuyler mine at Arlington, N. J., was a failure as a copper producer, but its dark, damp workings in red sandstone are ideal for raising musnrooms. The owner is seen doing a little selective mining.

Recent Developments in Underground Mechanical Loading*

New Butler Shovel a Simple Rugged Machine That Can Be Readily Handled in Shaft and Heading—Its Relation to Other Devices for Mucking

By Charles E. van Barneveld
Supervising Mining Engineer and Metallurgist, Mississippi Valley Experiment Station, U. S. Bureau of Mines, St. Louis, Mo.

FOR three years the Bureau of Mines has carried on more or less intermittently an investigation of mechanical underground loading in metal mines. This work was begun by C. L. Colburn, who made a preliminary report which was published in December, 1921[1]. The investigation was taken over by me in July, 1922; the scope of the work was enlarged; field work will be completed within a month; a report will be prepared promptly, to be published by the Missouri School of Mines and Metallurgy, which institution is the co-operative agency of the Mississippi Valley Station of the Bureau.

The outstanding developments in this field since the issuance of the preliminary report mentioned are:

1. The extension of the use of scrapers in sublevel drifting and slicing on the Lake Superior iron ranges.

2. The successful introduction of the Mayne loader in sublevel drifting and slicing on the Marquette iron range.

3. The adoption of scraping in stopes and drifts in western metal mines.

4. The working out of the idea of multiple car loading—that is, loading a train of cars by means of scraper and slide with variable degree of mobility.

5. The evolution of the Conweigh loader (belt type). This machine was developed in the southeast Missouri lead belt to meet the peculiar local conditions there. Its original application was in narrow stopes of variable height and for fairly heavy service in disseminated lead ore in limestone. The ore broken in a heading seldom supplied the loader for an entire shift. Frequent moves were necessary; this in turn required a loader built low enough to travel through drifts and under trolley wires, and resulted in the development of a simple, rugged, dependable, electrically-operated, track-mounted machine with its own motive power. The moderate price of this machine together with its record for endurance in hard service at reasonable maintenance cost has led to its adoption in several nonmetallic mine loading problems, such as salt, shale, and coal, as well as in the lead and zinc mines of the Mississippi Valley.

6. The perfecting of the electric shovel developed by the St. Joseph Lead Co. This shovel is described by the designer, A. K. Mitchell,[2] of the St. Joseph Lead Co. After an extensive trial of the Thew mining shovel in all three divisions of this company, the management concluded that mechanical loading must be extended to include a larger proportion of the output and therefore set about to design a shovel of sufficient flexibility to fit stoping conditions which include a height of ore varying all the way from 8 ft. to 100 ft., averaging a little less than 25 ft.

The principal requirements this shovel must satisfy may be recapitulated briefly as follows:

(a) Capacity: large capacity in rough blocky ground when the opportunity offers to load a large tonnage from a single heading.

Rapid digging under all ore conditions; ability to load over an obstruction such as high bottom.

(b) Maximum mobility: the machine must be mobile enough so that it can travel comparatively long distances over fairly rough ground speedily and without excessive strain on the machine when mining conditions compel loading in scattered headings in order to maintain sufficient output to warrant the maintenance of a shovel. Proportions and weight must admit of loading the machine on a small truck for rapid transportation over long distances about the mine.

(c) Dimensions, both vertical and horizontal, while digging and traveling should be within a range to insure economical operation of the shovel throughout the mine. This calls for a machine that can travel in a 7x7-ft. drift, load in an 8-ft. heading, clean up a 30-ft. breast from a central position and still swing clear between closely spaced pillars.

(d) Dependability: freedom from breakdown; positive prevention of overstrain; ease and simplicity of operation.

(e) The machine should show over a period of years a reasonable gross loading cost—including operation, maintenance, interest and depreciation.

I have observed the operation of the original experimental shovel and the recently acquired new shovels, in the Bonne Terre and Rivermines divisions of the St. Joseph company, and it appears to me that these machines are fully up to expectations and satisfactorily meet the above mentioned requirements. In loading, the shovel operates with speed and precision; it handles heavy blocky ground well. The long crowd enables it to load at nearly any vertical position of the dipper and boom, so that "high bottom" need never delay the machine, as the dipper may be raised over the obstruction. The ease with which the machine moves in, changes position, and the businesslike way in which it attacks the muck pile, the simplicity of control and the ease with which the operator handles the day's work cannot fail to impress an observer.

Butler Shovel Invades Scraper Field

7. The successful demonstration at the Waco, Mo., mines of the Barnsdall Zinc Corporation of the latest model Butler shovel, which invades a field hitherto covered only by the scraper and thus promises to meet the need of the western miner for a small, flexible, machine, readily movable on mine cage from one level to another, available alike for loading in drifts—as

*Written specially for the *Engineering and Mining Journal-Press* and published by the permission of the Director of the U. S. Bureau of Mines.

[1]*Reports of Investigations*, Bureau of Mines, Serial No. 2300. Mining and Scientific Press, Jan. 28, 1922.

[2]Mitchell, A. K.: "St. Joseph Lead Company's New Mining Shovel," *Mining and Metallurgy*, Vol. 4, April, 1923.

small as 4½x7 ft.—and for fairly heavy loading in comparatively large tunnels, stopes and rooms.

Many inquiries have come to me from western operators regarding loading devices suitable to western conditions. The essential requirements are: reasonable

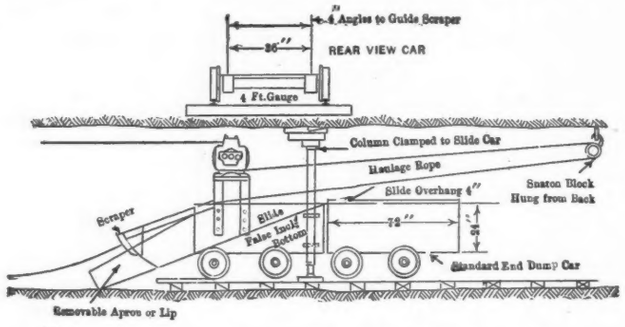


Fig. 1—Scraper car loader developed by Calumet & Hecla Mining Co., Michigan

first cost and maintenance, low power consumption, simplicity of operation, extreme flexibility—including in this term portability and all-around use in drifts, tunnels, stations, stopes and chambers, having a wide range of size and shape. Inasmuch as an answer to this question is now available and the Bureau's complete report will not be ready for distribution before the end of the year, this seems an opportune time to contrast western scraper loading practice with the accomplishment of the Butler shovel.

Loading With Scrapers

The first application of mechanical underground loading in mines on record[3] was witnessed by me twenty-six years ago in the driving of the Bunker Hill & Sullivan's main tunnel at Kellogg, Idaho. A rock section 10x11 ft. in quartzite was advanced by the heading and bench plan at a rate of from 250 to 350 ft. per month, this rate being made possible by the use of a slip scraper which permitted the loading out of 40 to 50 cars (capacity 1 cu.yd.) in from two to three hours, the time depending largely upon whether sufficient powder had been used to break the rock (quartzite) fine enough for rapid scraper loading.

The outfit as developed by A. B. Hough, the engineer in charge of tunnel construction, comprised the following: A single drum, two-cylinder Bacon hoist mounted upon a movable frame set over the track so as to clear the cars which passed under it. Placed between the hoist and the breast was a movable mucking frame and an incline designed so that two mine cars of 1 cu.yd. capacity could be pushed under the end of the frame. The loading opening was cut in the end of the platform so as to fill the end car first; when loaded, this car was pulled forward and the second car brought under the opening. The cars were then trammed (together) by hand to a 200-ft. siding, where trains of fifteen to twenty cars were made up for haulage by a 4-ton electric motor.

Loading was done with a No. 1 slip-scraper or slusher, hauled up the incline by the hoist and pulled back by hand. Two to three scraper loads filled a car. A crew of five men was used: one man at the hoist, one man handling cars, three men loading and handling scraper. The rate of loading, including all hands—that is, tons of muck placed on side track per man-hour—varied from 4 to 5.5 tons.

Both the hoist platform and the scraping platform were readily moved. A special framework was built, mounted on a car truck, and provided with four jackscrews, to run under and pick up the hoist platform, which could then be moved at will. A similar contrivance was used to move the mucking platform. A car, carrying four jackscrews made from worn-out machine-drill feed screws, was run under the platform, which was then jacked up until its entire weight rested upon the car. The frame could then be pushed back to permit advancing the track, and later moved forward nearer the face and lowered in place.

This installation is the prototype of the various stationary and movable scraper mucking devices hereinafter enumerated with very brief description and comment:

1. Mucking directly into a mine car (1 to 4-ton capacity) up an inclined plank slide, using slip scraper or rake scraper and single drum tugger hoist, returning scraper by hand. The scraper may approach the end of the car or the side. Maximum distance 25 to 35 ft.

2. Mucking directly into a mine car up an inclined platform (fixed or movable) or mucking directly into a chute, using a box type or a hoe type (single or reversible) scraper, and double-drum air hoist with main and tail rope. Curves and right angle bends are negotiated in various more or less successful ways; in some mines right angle turns are handled by scraping twice, to and from the turn. Maximum distance 75 to 125 ft.

3. A movable installation developed at the Calumet and Hecla mines, Michigan, consisting of: A mine car provided with a false inclined bottom and a removable metal front apron or lip, which together form a continuous slide from the ground to the top (at rear) of car; a 6-H Little Tugger double-drum hoist is mounted above the car on a platform which sets on straps bolted to the sides of the car. The car is anchored at any desired point by a column wedged to floor and roof which passes through two semi-circular collars bolted to the side of the car. One or more regular mine cars (capacity in this mine 36 cu.ft.) are then backed up to the anchored car, and connected with a 4-in. angle-iron track to serve as guide for a single-edge hoe scraper. A snatch block is then hung in the back to guide the haulage rope and another snatch block is hung in the face to guide the tail or return rope, as shown in Fig. 1.

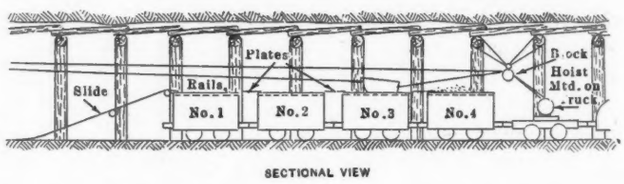


Fig. 2—Scraper car loader developed at Newport iron mine, Ironwood, Mich.

4. A movable installation developed at the Newport mine, Ironwood, Mich., consisting of a locomotive, a flat car or truck upon which a hoist is mounted, a train of cars, and a removable mucking slide. This

[3]Hough, A. B., "The Kellogg Tunnel." *Mines and Minerals*, October, 1901. *Engineering News*.

train is backed into the drift to be mucked, the slide is set up, the space between cars is bridged by means of plates having turned-over edges (each plate riveted to one car only, thus offering no obstacle to passage of train around curves). Rods, straps or rails are used lengthwise of the cars to prevent the scraper from digging in. A snatch block is hung at the breast and another immediately above the hoist. The hoist is connected to air line or (if electric) to the trolley wire and scraping may begin. The cars are first loaded level full in succession, beginning at the car nearest the breast. If the cars are to be crowned, then, after all cars have been loaded level, the next scraper load is "heaped" onto the car nearest the motor, and working towards the slide, the other cars are similarly "heaped."

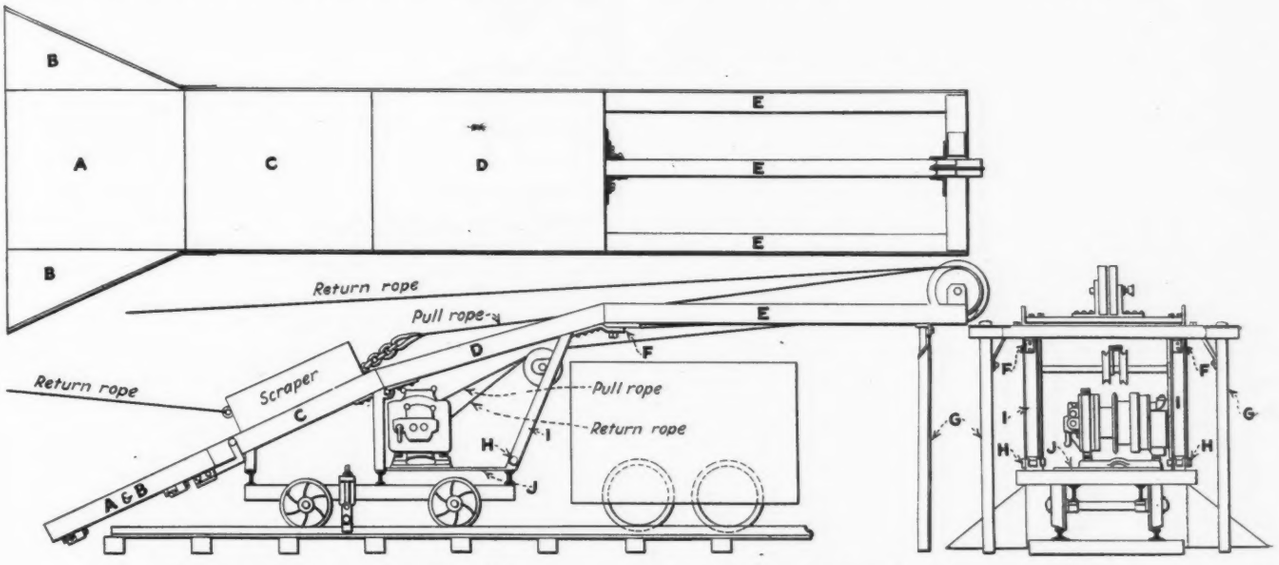


Fig. 3—Wagner collapsible slide, a movable installation developed at Ironwood, Mich.

When the train is loaded, the entire outfit is taken on board and the train pulls out (Fig 2).

5. A movable installation developed by A. J. Wagner, Ironwood, Mich., consisting of a hoist and a collapsible metal slide, both mounted on a truck which is clamped to the rail during mucking operation. The slide terminates in a horizontal loading platform of proper height to clear the car. The scraper dumps its load direct into the car through an opening in the loading platform.

Fig. 3 shows the Wagner slide ready to load. When it is desired to move the slide any distance, it is collapsed in the following order: Section *A*, which is attached to section *C* by a pair of offset hinges, is raised and folded back on section *C*; sections *B-B* are then folded over on to section *A*; next section *E* is lifted out of slot *F* and placed on tram car; section *G* is then removed and *E* is laid flat on tram car. If chutes and drifts are lower than 5 ft., the pins *H-H* can be pulled and section *D* may be lowered to the height of car. After lowering section *D*, pins *H H* should be replaced into *I* and rested on plate *J*. This slide should give satisfactory service when used with large cars, provided steps are taken to give adequate transportation service.

6. Semi-stationary sectional metal slide consisting of a hoist mounted on rear end of sectional metal platform, with movable slide, arranged to muck a train of cars, developed for small drifts by the Anaconda Copper Mining Co., Butte, Mont., by which the following data were furnished (Fig. 4):

Mechanical mucking operations at the Anaconda company's mine at present are confined to mucking in drifts and crosscuts by reversible hoe-type scrapers pulled by double-drum compressed air hoists working at about 80 lb. air pressure. No type of Tugger hoist has been accepted as standard; the Ingersoll-Rand Little Tugger 6-H, the Denver Rock Drill Waughoist Model 300, and the Sullivan Turbin air hoist 283 H.C.A. double drum are all represented.

The general conditions which control development work are as follows:

Drifts 8 x 11 ft. outside and 4 ft. 1 in. x 7 ft. 2 in. inside timbers.

Crosscuts 6 x 8 ft. Mine cars 14 cu.ft. capacity.

The outfit which is now being tested at the several mines of the Anaconda company comprises:

(a) A steel scraper of the reversible hoe type, having one removable knife edge and the other side provided with Calumet steel teeth. Weight 580 lb. Capacity 15 cu.ft.

(b) A light metal slide and platform. The slide is 12 ft. long and is set at 23 deg. to the horizontal. At its junction with the platform a 6-in. steel roller has been placed whose top surface is ½ in. above the bottom of the platform. This roller lessens friction, thereby doubling the life of the rope. The platform is 38 in. wide and 16 ft. long; a hole is provided near the rear end through which the car below is loaded.

(c) A double-drum compressed air hoist mounted on the rear of the platform and operated from a seat on the platform.

Before blasting, the slide and platform are moved up to within 10 ft. of the face of the crosscut, the front end of the slide is blocked in place between the sides of the crosscut. After blasting and barring down, the engine is set in place on the rear end of the platform and a 4-in. machine bar is set up across the face of the crosscut, a 10-in. pulley carrying the return rope is attached to the bar, the scraper is attached to the ropes and mucking begins. Four empty cars at a time are pushed under platform.

Mucking is continued until the bottom is cleaned out; muck on sides is left until the final clean-up, when the slide is moved foreward. Slide and platform are left in place while drilling, blasting and timbering operations are carried on. They are moved forward every 40 ft., at which time muck on sides is cleaned out and track is laid.

The time of operations in untimbered crosscut or drift is as follows: Barring down 1 hour, rigging up bar and

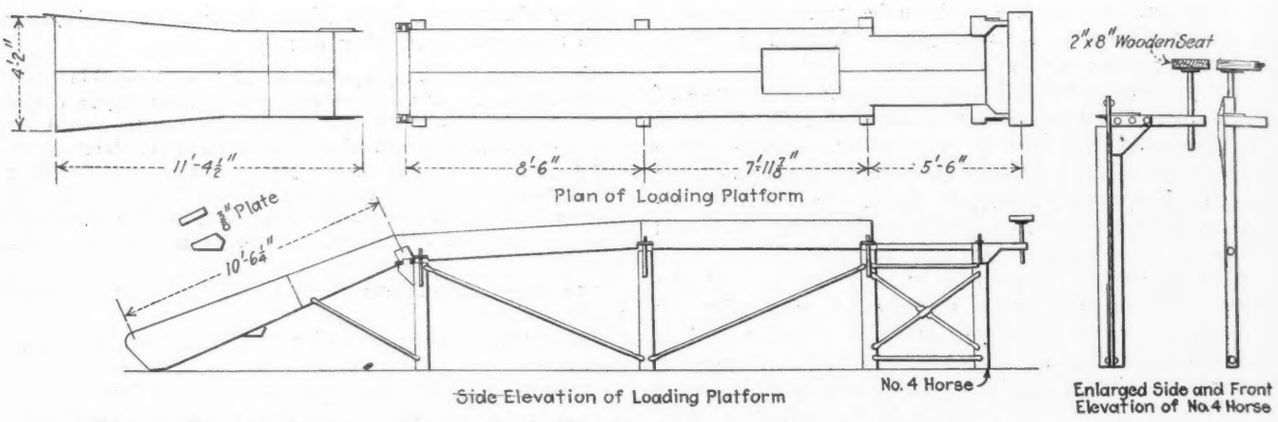


Fig. 4—Semi-stationary sectional metal slide for scraper loading developed by Anaconda Copper Mining Co., Butte, Mont.

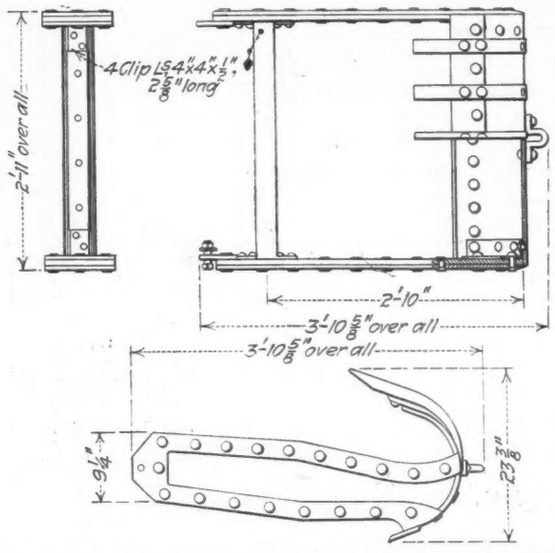


Fig. 5—Steel scraper of reversible hoe type developed by Anaconda company

rope 30 minutes, mucking 2½ to 4 hours, drilling and blasting 3 to 6 hours. The average round of muck is 40 mine cars or 28 tons; the rate of mucking is 10 to 16 cars or 7 to 11 tons per hour.

The general feeling among mining men in Butte is that scraping is still in the experimental stage and that no definite conclusions have been reached. The indications are that the scraper installation, which costs around $1,000, effects:

(a) A very decided saving in time, as it insures, under normal conditions, the completion well within the net working time available in one shift of a full drifting or crosscutting cycle—namely, mucking out the previous blast, drilling a round, and blasting before going off shift.

(b) Reduced physical effort on the part of the men, thereby attracting the best class of American-born underground labor.

(c) No reduction in the number of men employed.

(d) A slight decrease in cost per foot of advance.

7. Use of scrapers in stopes: Scrapers have been used extensively on production. In the iron mines of the Lake Superior district they are used in sublevel drifting and slicing and in sublevel caving practice in soft and medium hard ore. Heavy scrapers weighing from 1,000 to 1,400 lb. are used in one mine in very hard specular hematite, which is mined by room-and-pillar system; the broken ore is very heavy and chunky, half-ton boulders being quite common; this installation is a success.

In the zinc mines of Missouri scrapers are used to advantage in long narrow "runs," and are very effective in maintaining the "balance" of production in mines using both hand shoveling and mechanical shovels (as distinguished from scrapers).

In the western mining districts, scrapers are used in connection with some large mining operations, but more particularly in veins of low dip (15 deg. to 35 deg.) where the ore will not run down the chute by gravity. Figs. 9 and 10 illustrate a case in point. A 30-in. box scraper, weight 125 lb., capacity 8 or 9 cu.ft., is used in flat stull stopes, dip 20 deg. to 30 deg., height 5 to 12 ft., and is operated in the raise by a modified double drum Anaconda hoist (about 12 hp.).

The loading operation requires two men; one in the raise and one running the hoist. The usual practice at this mine is to scrape 12 scraper loads at a time down into the chute, then tap this off into cars (making 6 small cars), which are trammed together. The scraper tender rides the scraper. This crew makes about 20 small cars per shift, but could readily handle 40 or 50 cars if the ore were available.

Fields Vary for Different Machines

The diagram in Fig. 6 shows in a very general way what appears to me to be the specific field of the various

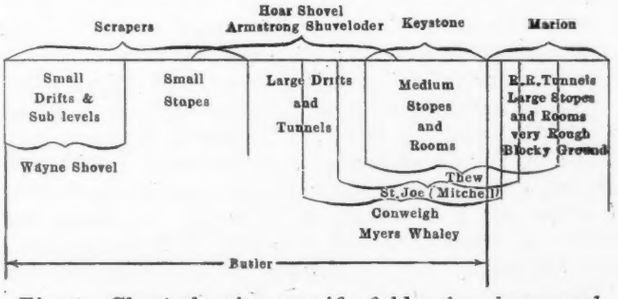


Fig. 6—Chart showing specific fields of underground loading machines

machines and also to indicate the degree of overlap into other fields.

The range of the St. Joseph machine is greater than the range of the Thew on account of its availability for loading in wide drifts and low ground. It is probable that the Thew would make a better showing in

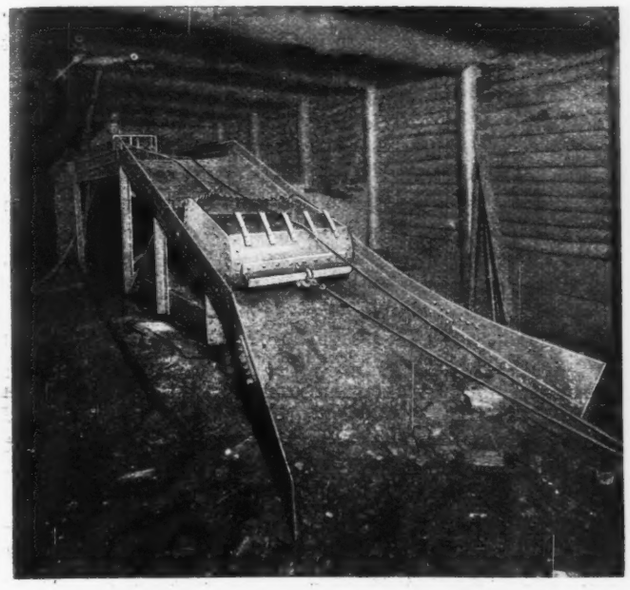


Fig. 7—Anaconda-type scraper in use in Michigan. This is the James mine slide

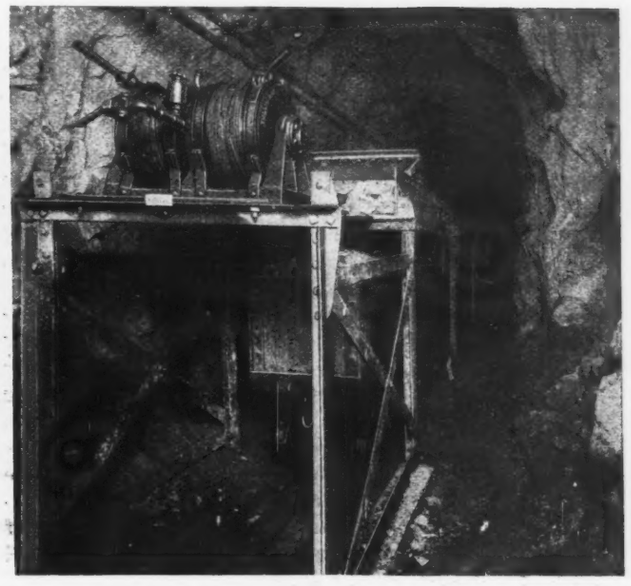


Fig. 8—Anaconda sectional slide (also shown in Fig. 4) in use in Butte copper mine

very rough blocky loading and it has been so indicated in the chart. The Keystone is a very satisfactory machine in high stopes with ground not too coarse and blocky, while the special field of the Marion is the loading of large tonnages in heavy blocky ground.

Thus the field of the Mayne shovel appears to be limited to small drifts and sublevels, particularly in soft ore. The scraper, on the other hand, may be used in both soft and hard rock drifts and also in small stopes. The particular field of the Hoar and the Armstrong Shuveloder is large drifts and tunnels, with some overlap into small stopes and into medium-sized stopes, rooms and chambers. The Conweigh and the Myers Whaley are particularly adapted to the whole range of large drifts and tunnels, medium-sized stopes and rooms, and they overlap somewhat into the field of loading rough blocky ground in large stopes and rooms; this is particularly true of the Conweigh.

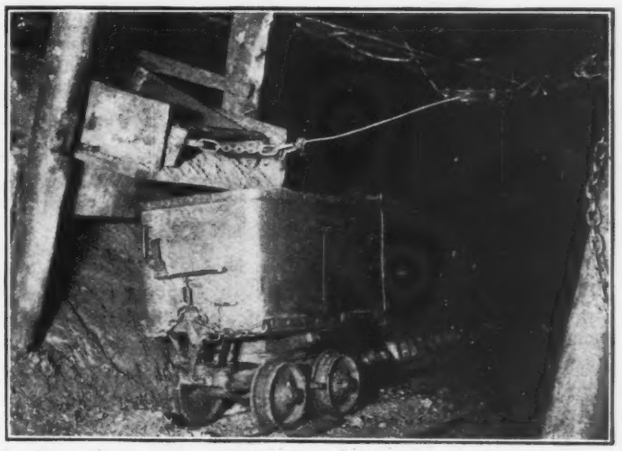
Butler Shovel for Wide Range of Service

The Butler shovel or "Shuveloder," as its manufacturer calls it, is a small single-cylinder air-operated shovel of the revolving type. Its design incorporates many novel features which combine to produce a simple, light yet rugged machine, with very low power requirements, adapted to a wide range of service.

Though the operation of the machine is simplicity itself, a simple straightforward description presents difficulties because the principal parts each perform several different and closely interrelated functions during the successive motions included in a complete operating cycle. The machine consists essentially of three main parts: (1) base, (2) cylinder, (3) dipper assembly. These will be described in outline, followed by a detailed description of the chief special functions of the interrelated parts.

The Base.—The trucks carry the stationary member of the turntable. Supported on this turntable by a double row of balls is the revolving member, which contains a 3-hp. double acting 2-cylinder oscillating engine, which revolves the turntable. On this revolving member are cast the side frames that support the cylinder. The entire base is made of No. 3 artillery steel; it is protected from dirt and grit and is automatically lubricated by the oil contained in the exhaust air. Auxiliary means are provided for oiling the crank bearings.

The Cylinder.—There is one cylinder only, supported at its trunnion by the side frames. The cylinder is



Figs. 9 and 10—A scraper at work in a stope. The scraper tender rides the scraper

steel tubing and the trunnion, yoke and heads are made of artillery steel. In this cylinder are the two pistons, each secured to a hollow piston rod, one within the other. The valve controlling the movement of the pistons is incorporated in the cylinder trunnion and is operated directly by a hand lever. On the bottom of the cylinder is a bracket which engages with the base to take the back thrust when crowding, instead of absorbing this thrust at the trunnion point, thus avoiding strain on the mechanism and tendency to pull up the track.

The Dipper Assembly or Mounting—The frame carries a pair of guide and supporting arms with their links, which are attached to the rear of the dipper arms. The dipper is mounted on the front end of these arms in such a manner that when the air pistons are spread apart the dipper rocks on its pivot with a scooping action. A pair of hydraulic pots whose pistons are attached to the supporting arms, control the dipper during the entire elevating stroke, determine the path of the dipper while extending prior to dumping, and cushion the descent of the dipper.

Developed After Long Experiment

This machine was developed by R. S. Butler, assistant manager, Barnsdall Zinc Co., Joplin, Mo. The first operating model was constructed locally at the mine at Waco, Mo., in September, 1919. Successive models were built in November, 1919, and May, 1920, July, 1920, and November, 1920. The last mentioned model was in successful, though intermittent, operation for two years —long enough to determine the value of the split piston and other novel ideas and to prove that the lightness of this machine was not a deterrent to heavy loading. The Lake Superior Loader Co., Duluth, Minn., then took over the manufacture and sale of the shovel. A sixth experimental model was designed incorporating the ideas developed during the use of the machine in the mine; construction was half completed when Mr. Butler decided to incorporate in this design some new ideas requiring radical changes: in former models the dipper was extended by means of slides and rollers; in the seventh model these were superseded by the parallel motion (described later) which eliminates all rolling and sliding surfaces and with them 90 per cent of the friction in external moving parts. This seventh model was delivered at the mine late in May, 1923. It was given a thorough surface test and was handled very roughly to show in detail the action of each member under every conceivable condition of strain. It was evident that the underlying principles of design were correct and that no radical or fundamental changes need be made. Several minor changes, however, were indicated. So far as possible these were made and tried out.

The shovel was then taken underground and subjected to the roughest loading conditions presented in the mine. These conditions may be characterized as "average"; not nearly so severe as the heavy, blocky, slabby rock commonly found in the large stopes in the lead belt of southeast Missouri, or the heavy, sticky, packed iron ore characteristic of some of the soft ore iron mines of Lake Superior, or the blocky granite and gneiss frequently encountered in driving large tunnels in the West; yet severe enough when accompanied by deliberate rough treatment to bring out any inherent defect. After a month of this service the production engineer, in charge of construction of this machine at the Nordberg plant, who witnessed all these tests, returned to Milwaukee; the numerous minor changes indicated were incorporated in the design, the necessary changes in patterns were made and commercial production was begun.

The limiting dimensions of the machine are (see Fig. 11): 45 in. high, 30 in. wide, 6 ft. long with dipper down; 38 in. long, and 7 ft. high with dipper up. Weight: 3,500 lb. It can be taken down in a 30x38-in. cage having 7 ft. headroom, without dismantling. It is almost as movable as a mine car; on a good track it can be pushed ahead by two men. With the small dipper (5½ cu.ft.) it will work in a 4½x7-ft. drift. It will dig 8 in. below the rail and has a 7½-ft. clean-up radius; that is, it cleans up a 15-ft. circle and will dump its load anywhere within that circle; the maximum dump either to side or rear for small dipper is 6½ ft. from center line of machine. With a 7½-cu.ft. dipper it cleans up an 18-ft. circle; that is, a 9-ft. radius. The wheel base is 30 in.; track gage from 18 in. up. The weight of rail is from 16 lb. up, preferably 20 lb. Heavy ties and splice bars are not necessary. The machine is very easy on the track. Equipped with small dipper, the shovel will muck out a 6-ft. break without requiring new track to be laid during mucking; equipped with large dipper, it can handle a 7-ft. break.

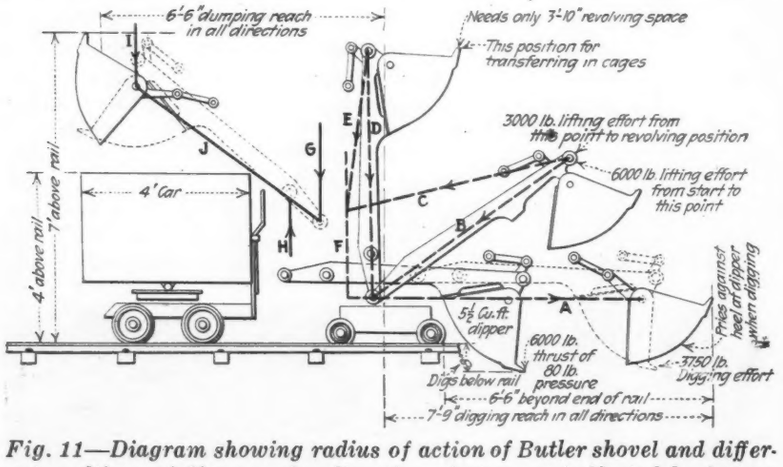


Fig. 11—Diagram showing radius of action of Butler shovel and different positions of dipper; also direction of stresses indicated by letters

The peculiar digging action of the machine is best characterized as a "scooping" action; this contributes largely to the efficiency of the machine, to its low air consumption and freedom from heavy transmitted strain during heavy digging. Crowding is accomplished with the dipper on the ground for such portion of the forward stroke as may be necessary. The dipper can scoop coincidentally with crowding or can stop crowding and then scoop. The scooping action is most effective in filling the dipper, the average dipper load being close to capacity. Power consumption during loading is remarkably low; this is explained largely by the following facts: (1) the dipper rests on the ground, or rather pries against the ground while scooping; (2) the scooping radius, compared with other types of shovels, is short. A glance at positions 2 and 3 of the dipper in Fig. 11 reveals this latter fact; the scooping radius (that is, the distance from dipper hinge to digging lip)

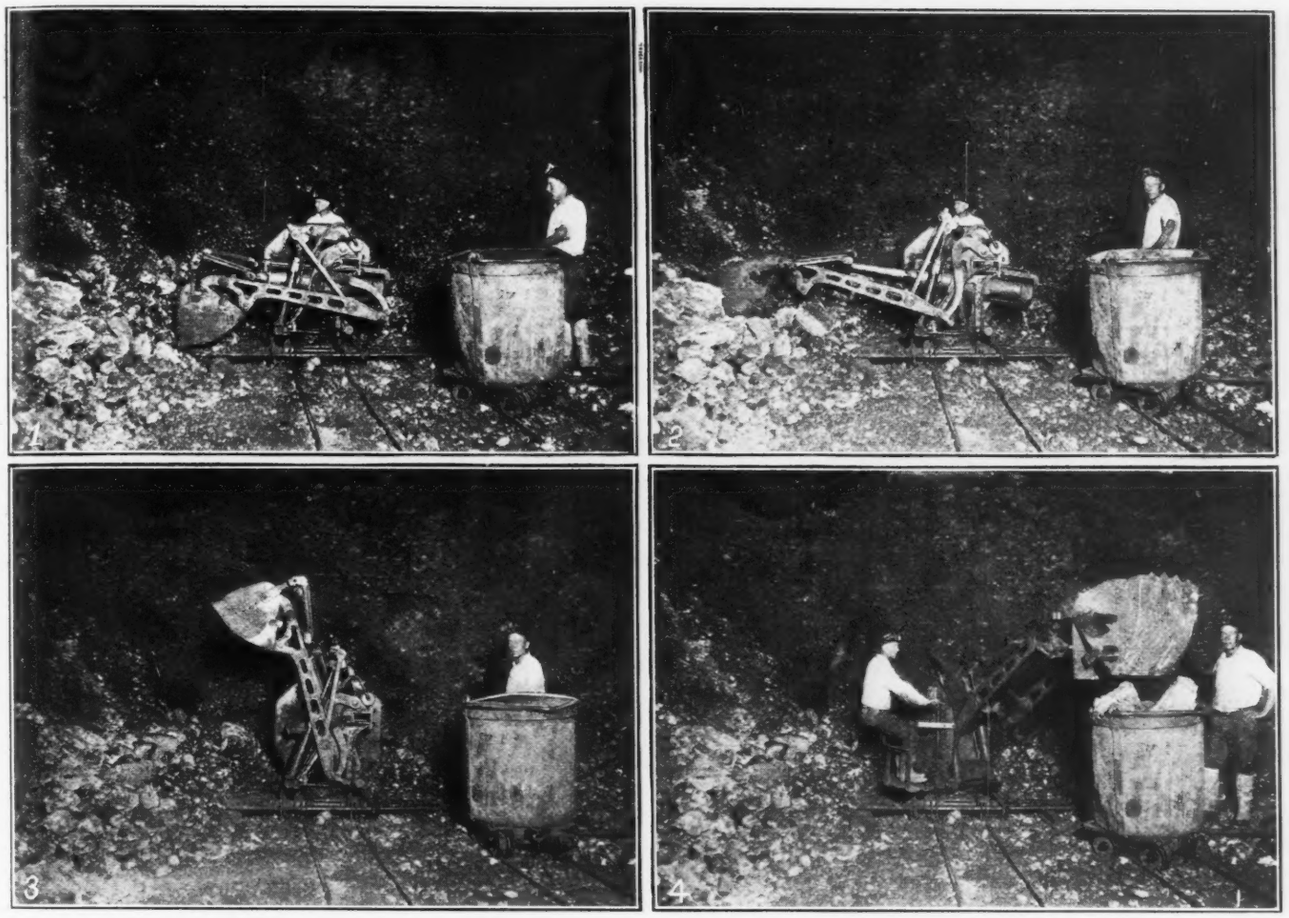


Fig. 12—Butler shovel in mine of Barnsdall Zinc Co., Waco, Mo., loading 1,400 "cans." (1) Beginning to crowd. (2) End of crowd. (3) Revolving position. (4) Dumping

is 18 in. in the small and 22 in. in the large dipper. The power needed for scooping for any type of shovel is directly proportional to the scooping radius. Irrespective of the question of power consumption, the short scooping radius is more effective for filling the dipper than the longer radius. Incidentally, the strain transmitted to the body of the machine is very light; this is proved by the fact that a shovel which on good track can be moved by two men will scoop (not crowd) without being clamped to track.

Will Not Pull Up Track

The shovel is clamped to the rail with clamps similar to those used on the Hoar and the Armstrong Shuveloder. In the present model of the Butler machine old clamps were used and the time required for moving up was excessive. From observations made by me on Hoar and Armstrong Shuveloder drifting operations using the latest form of rail clamp, the move-up need not take over two minutes with the Butler, and moves are less frequent. When loading in front and dumping in the rear, as would be the case in a small drift, no stabilizer is needed. When loading from or dumping to one side, a simple crossbar (plainly visible in the photographs) is used and wedged to the ground by wooden blocks. The shovel will not pull up the track, as the back thrust is absorbed at a point on the base of the machine 10 in. above the rail.

Any attempt to describe in logical order the special construction of the machine and its special operating features encounters the aforementioned difficulty of interrelated movements and different functions of the split piston, the hydraulic pots and the various cushioning effects at different positions of the operating cycle. Therefore the reader is advised to glance at the underground views and at Figs. 11, 13, 14 and 15 in succession prior to studying the following detailed description:

Key to Layout. (Fig. 11)

Position 1. Starting position. Shown here with dipper 8 in. below track. May start with dipper considerably above the track. (This corresponds to photograph No. 1, above.)

Position 2. Limit of crowding stroke. (This corresponds to photograph No. 2, above.)

Position 3. Pistons have spread, causing dipper to dig (that is, scoop). The dipper pries against the ground, thus relieving the body of the machine from the strain usually set up by this operation. The operator can dig at any position between (1) and (2) either above or below rail. It is not necessary to complete the crowding stroke in order to begin the next movement. This is true for any movement of the machine.

Position 4. The hydraulic pots at this point have ceased to function as a fulcrum on the dipper arms and the applied power ratio drops from 1:1 to 2:1. (This is all automatic.) All the operator does for *any operation* is to move his cylinder control lever on the cylinder trunnion. (The only exception to this statement is when the operator drops dipper to starting position).

Position 5. Revolving position. The loaded dipper has come home and is held there by the pressure of air in the cylinder, admitted during the elevating stroke. After the body of the machine has been revolved, the air is released

and the dipper runs out over the car, or as far as the operator desires. (This corresponds to photograph No. 3, page 507.)

Position 6. Dipper in extreme reach for dumping. Dipper may be dumped anywhere between (5) and (6). (This corresponds to photograph No. 4, page 507.)

Position 7. Extreme dumping position. The same arrangement of pistons in the cylinder that causes the dipper to dig causes it to dump. The lid that forms an integral part of the dipper when crowding, scooping and elevating, is automatically held away from the dipper when dumping. There is no loss of clearance over car when dumping. After dumping, the dipper is pulled back to position (5), swung around and the arms are released by the foot pedal, the cylinder and dipper swing down to (1). Their fall is checked by the hydraulic pots, which discharge at a predetermined speed.

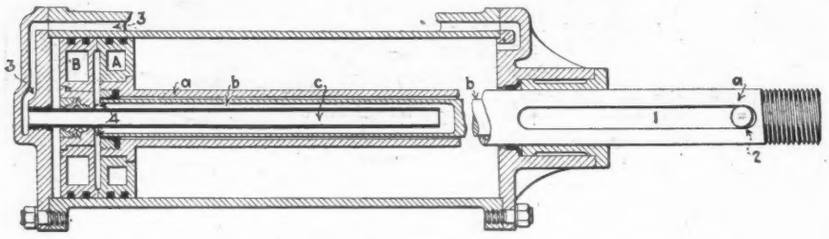


Fig. 13—Diagrammatic view of cylinder, cut away to show double or split piston

Fig. 13 is an idealized or diagrammatic view of the cylinder cut away, revealing a sectional view of pistons and rods. It shows the following:

Front piston (*A*) attached to outer rod (*a,a*) which is a hollow steel tube slotted at one end (1) to allow pin (2) to slide the length of the slot.

Rear piston (*B*) attached to inner rod (*b,b*) hollow for part of its length and solid on the front end, drilled to receive pin (2).

Tube (*C*) attached to rear cylinder head, of lesser diameter than bore of rod (*b,b*), and extending nearly to front cylinder head. Rear end of tube communicates with cored passage in cylinder (3,3). Front end is open and communicates with annular space within rod (*b,b*). Ports (4) in the inner rod lead from this annular passage to space between pistons (*A*) and (*B*).

When the two pistons move in unison, air is admitted to either end of cylinder through the usual ports (rear port not shown) by a rotating movement of the main control lever. A sliding movement of the same lever spreads the pistons; air is admitted to passage (3,3) and passes through the open front end of tube (*C*), back through the annular passage, thence through ports (4) and between the pistons, causing them to spread. By changing the position of the control valve, the flow is reversed and pressure on outside of either piston causes them to close up again. Leakage around rods is prevented by suitable packing on each piston head.

With this arrangement it is possible to spread the pistons at any point in their stroke. Under certain conditions, when spreading the pistons, the rear piston may move back, or the front piston may move forward, or both may move in either direction with relation to the cylinder. Conditions at the point of the dipper determine this. The only requirement when scooping or dumping the dipper is that the pistons spread apart.

A pair of oscillating cast-iron cylinders called "hydraulic pots" have a very important function. At the base of each pot is a hub and there are two corresponding hubs on the revolving member of the turntable. A "through" shaft marked "1" on the numbered view in Fig. 14 passes through these four hubs and forms the pivot on which these two hydraulic pots oscillate. The two pots are connected to a common reservoir cast in one piece with the pots; the pressure in both cylinders is thus equalized. The upper and under sides of the pistons communicate through ports with the connecting reservoir. The displacement of the pistons is accommodated by compensating chambers, one bolted to each pot. The bonnet of the releasing check valve is screwed into the casting. The hydraulic pistons are fitted with two cup leathers each. There are no check valves in the hydraulic pistons. The releasing valve allows the fluid to pass from the reservoir through the valve and into each cylinder when the hydraulic pistons are moved upwards, but prevents fluid from being displaced (reversing the flow) when downward pressure is applied to the hydraulic pistons. When it is desired to allow the hydraulic pistons to descend, the operator releases the valve and the fluid flows from cylinders back into reservoir at a predetermined rate (1½ seconds) slowly enough to prevent the dipper (which is attached to the hydraulic pistons by means of links running from the dipper arm to the supporting arms, which, in turn, are connected directly to the hydraulic pistons) from jarring by too sudden a drop.

Method of Operation.—The following description of the hydraulic pots refers to the numbered side view, Fig. 14. (Only one side of the machine is shown and all members mentioned in the text are in pairs):

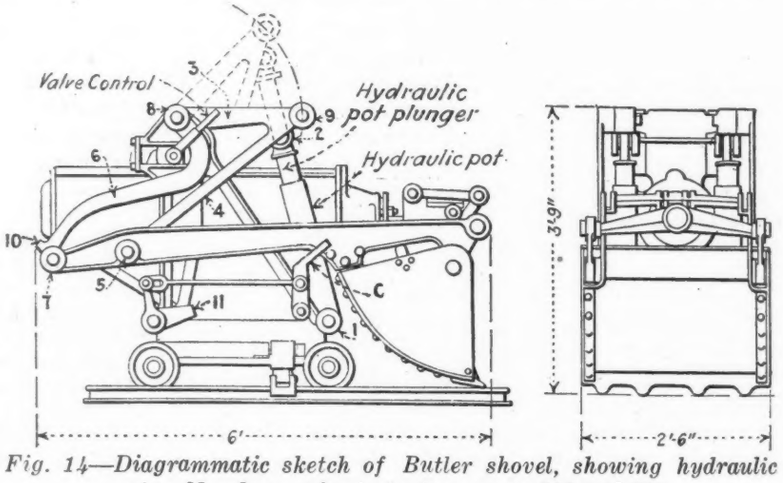


Fig. 14—Diagrammatic sketch of Butler shovel, showing hydraulic pots. Numbers refer to text on pages 508 and 509

The dipper beams or arms are connected at (7) to the guide arms (6); at (5) to the links (4). These links are connected to supporting arms (really one forked member) (3) by pin (9). The hydraulic pistons are connected to supporting arms (3) by pin (2). Supporting arms (3) and guide arms (6) are connected to the frame of the machine by shaft (8) and are free to oscillate on this shaft when following the movement of the dipper arms. Guide arm (6) describes an arc about shaft (8) and so does supporting arm (3), which is at its lowest point when dipper is

in starting position. As dipper moves out, no matter whether digging above or below rail, the link (4) connecting dipper arms with supporting arm (3) causes the latter to move upward, carrying the hydraulic pistons upward also. The fluid in the two hydraulic pots (above the piston) flows through port and check valve to the underside of each piston, allowing the dipper to move forward when digging, making its own path, unrestrained and uninfluenced by its mechanical mounting, just as if the hydraulic pots were not present.

When the action is reversed the dipper cannot retrace its path because check valve holds point (9) fixed. The dipper arm is then supported by link (4) at point (5) which in combination with point (7) on the guide arms acts as a double fulcrum, and when drawn back the dipper is raised off the ground. To what height this action of the hydraulic pots raises the dipper depends upon the height to which point (9) has been raised; and this in turn depends on the distance traveled by the dipper at the moment. By this action of the hydraulic pots the loaded dipper is started on its upward travel under the most favorable conditions as regards power and absorption of strain.

One pound of energy in the cylinder will raise practically one pound weight at the dipper. Not only does this reduce the air consumption, but it permits instant starting of the heaviest load with the least strain on machine. After the load has been started, and it has gathered considerable momentum, the lug (10) attached to the guide arm comes to rest against a stop (11) on the frame, preventing dipper arms from passing any further to the rear. This changes the power application and the hydraulic pots cease to function as a fulcrum and are changed from supporting to driven members. As the dipper arms continue their upward travel (being pulled up by the air piston on its rearward travel) the links (4) force the supporting arm (3) still further upward and consequently the hydraulic pistons also.

The elevating stroke of dipper is controlled by the flow of liquid through a port having a variable opening which may be regulated to retard the end of stroke, this providing a cushion. When the air pistons have reached the rear of the cylinder no further travel is possible—the dipper is in revolving position and the hydraulic pot pistons are at the top of their stroke. They cannot come down, as the check valve automatically holds the fluid in the cylinders. When the air pressure is released in the main cylinder the dipper is released from this position and is then supported again by the links (4) about the fulcrum (5). These links are now in tension. The dipper cannot rotate about—that is, drop down (5)—because it is guided on its rear end at (7) by the arm (6), which is now in compression.

When the dipper is run out to dump, point (9) being fixed, a sort of parallel motion between arm (6) and link (4) causes the dipper to move out in a straight path (slightly "down hill") as far as the stroke of the piston in the main cylinder will permit. When pulled back the dipper retraces its path exactly. When ready to recover to starting position the stop (11) on the frame engaging point (10) is thrown by foot pedal *C*, which first throws the stop and then, upon being pressed home, opens check valve in hydraulic pots, allowing dipper to drop quickly, yet being cushioned against jar; the speed of this operation is adjustable.

With the exception of this last operation, all operations of the dipper and hydraulic pots are controlled by the main valve and, while they may be regulated as to degree and speed, by the operator, for normal loading it is necessary only to throw the valve wide open for each movement. The machine is adequately protected by cushions and the operations may be run at top speed. The various motions here described are all automatically coordinated and require no manipulation at any time.

At first these pots were intended to be used with oil. It was feared that the oil might emulsify; therefore, water containing lubricant (such as Hydroglio or oil, less than 5 per cent) was substituted. This gives excellent service. Experiments are being carried on now to determine the best liquid combinations and the best leathers, packing, etc., for use in operation of this shovel.

Novel Features and Their Effects

The oscillating cylinder is an ingenious method of replacing two to four work cylinders. It gives better leverage for all power movements. The oscillating cylinder and floating dipper assembly is the radical departure which permits a light-weight machine.

The split piston provides a simple, positive, effective means of scooping at will, without entailing complicated or expensive designs; it also permits dumping

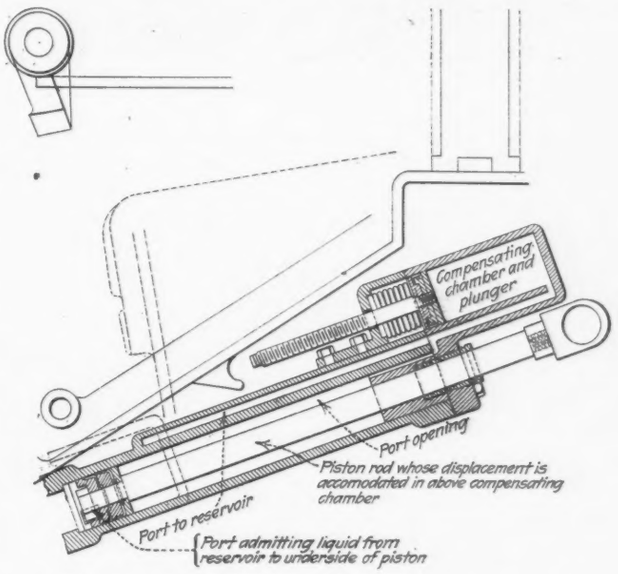

Compensating chamber and plunger
Port opening
Piston rod whose displacement is accomodated in above compensating chamber
Port to reservoir
Port admitting liquid from reservoir to underside of piston

Fig. 15—Sectional drawing of "hydraulic pot" of Butler shovel

the dipper in any elevated position without loss of headroom.

Application of the double fulcrum principle to a shovel is decidedly new and the hydraulic pots thus applied perform several very important functions: (1) A starting effort of 1:1 on raising the load. (2) Regulation of both upward and downward movement of the dipper, providing a cushion to prevent jar and undue strain. (3) Support for dipper in its elevated position and flexible control in this position unattainable by positive mechanical means which are necessarily flexible. (4) For trimming loaded cars, moving timbers, boulders, etc., the hydraulic pots provide a flexible control for the dipper path which results in quick and positive action. The position taken by the hydraulic pistons need not be exact in order to function properly—there is considerable latitude. (5) The parallel motion produced by the action of the hydraulic pots eliminates all rolling and sliding motions, transmits the strains to four pins, reduces wear and friction on moving parts.

Operation of Machine Readily Learned

The present model is a remarkably rugged machine, so simple in construction and operation that a new operator who has never handled a mechanical loader is easily broken in (as has been demonstrated at Waco). There are comparatively few moving parts and the wear is principally confined to pins and bushings easily replaced. This is not a cycle machine; it is flexible

Figs. 16 and 17—Butler shovel loading on a 15-degree incline

as a steam shovel and in normal operation is almost automatic. The operator throws the valve wide open; the movement requires no nursing, no delicate manipulation; the momentum of the moving parts is checked by air cushions in cylinder heads; the dipper strains are absorbed by the arms and hydraulic pots; the piston rods have only tensile and compression duties. There are no cables, chains, pulleys, or clutches; no rollers or exposed sliding surfaces to catch dirt and grit. There is one gear assembly only—ring gear and two mating gears for revolving motion—enclosed and thoroughly protected from grit, yet easily accessible for repairs. The machine will work at an air pressure of 60 lb., though 75 to 90 lb. is the desirable range. A computation of the air requirements indicate that 125 cu.ft. per minute is a high estimate. Only one air consumption test was made in the presence of the writer, which indicated an air consumption well under 125 cu.ft. (See Time Study No. 7, page 511.)

Several Special Operating Features

Among the special features of this shovel, attention may be called to the following: It will dig and load around corners, on a curve and to the side; it will move a boulder of such size that it recalls the picture of an ant struggling with a chip of rock. Moreover it will load on quite steep grades. The two photographs on this page show the shovel digging down a 15-degree incline. The shovel is held to the track by the regular clamps and the car is held by the hoisting cable. This experiment was tried in order to determine whether the shovel would meet the requirements of a customer—namely, to muck out a 15-degree incline.

Further Improvements in Design Planned

The principal changes to be incorporated in the eighth model, now under construction, are:

1. More accurate swing control.

2. Improvement in hydraulic pots, substituting the mechanical pressure arrangement in closed circuit herein described for the atmospheric pressure arrangement, with which model 7 was originally equipped. This change has actually been made at the mine in model 7 (now in operation); the arrangement necessarily was an unsatisfactory makeshift which proved the correctness of the principle and confirmed the designer's belief in the desirability of the change. The adaptation of this later idea necessitated a lot of joints, piping and "thimble-rigging" which got in the way of the moving parts, was knocked about and strained and developed bad leaks. This is the underlying cause of most of the "mechanical trouble" recorded in the time studies.

3. The truck wheels will be increased from 6 to 7 in.

4. Dipper construction changes: In the present dipper construction two 4-in. lugs connecting the dipper to its beams project out on the inside of the dipper, decreasing somewhat the size of the boulders the dipper can accommodate. The lugs will be outside the dipper in subsequent designs. The present method of hinging the lid will be changed to increase the effective discharge opening sufficiently to pass any size boulder that enters the dipper; the present opening is slightly smaller, causing occasional sticking of large boulders.

Durability of Machine Under Heavy Duty

Just how so light a machine will stand up against very heavy loading only time will tell. I observed the operation of the machine for one day when loading quite blocky ground which compares very well for roughness with average (not the heaviest) loading conditions in the southeast Missouri lead belt, and was most favorably impressed with the performance of the shovel in this respect. The design and consequent manner of minimizing and absorbing strains is decidedly in its favor. In order to emphasize this important point the directions in which power is applied and the lines along which stresses are developed have been indicated roughly on Fig. 11.

The line *A* shows direction of thrust in crowding. This originates at the base of the machine and is applied to the pin of the dipper. Remembering that the dipper rests on and pries against the ground, there can only be a direct crowding strain which is absorbed at the base of the machine.

In elevating, the dipper beams are under compression and again the strain is transmitted to the base, indicated by the line *C*. The line *F* represents the frame of the machine which is an *A* section that acts as a post for the other two lines (*B* and *C*). The line *E* indicates the direction of the force developed by the cylinder and is transmitted along the line *D* through the dipper beam to the base of the machine, the line *F* again acting as post. The line *I* indicates the dipper beam as a lever, the line *I* representing the load, supported by the lines *H* and *J*. With the dipper in this position bending strains are developed in the dipper beams. Bending strains are also produced in the dipper beams during the first part of the elevating stroke, which position is not shown in the diagram; the con-

ditions, however, are similar to those shown in the lines *G*, *H*, *I* and *J*.

A careful record was kept of all work done with the shovel in the Barnsdall mine, at Waco, Mo. The months of June and July were devoted to trying out various modifications. The tonnage loaded during the period aggregated 1,335 tons, ranging from nothing to 103 tons per shift.

In justice to the shovel it should be said that operating conditions are far from being ideal, regarded from a mechanical shoveling standpoint. Thus:

1. The mine is operated on the can hoisting system characteristic of the relatively short-lived, shallow mines of the Tri-State zinc district. These cans hold 1,400 lb., are 32 in. in diameter, and are set on a small truck. However economical this practice may be from the standpoint of initial hoisting and tramming equipment and of hoisting cost (and this is a debatable point where the life of the mine exceeds five years and the daily tonnage handled exceeds 750 tons), the practice is a direct hindrance to mechanical loading.

Robert S. Butler
Assistant Manager.
Barnsdall Zinc Co., Waco Mo., and inventor of the new shovel

2. This shovel was assigned (as a matter of necessity) to a portion of the mine where three drifts were advancing, respectively 18 ft., 24 ft. and 30 ft. wide, taking up a 12-ft. bottom or bench in each, the ore broken per round ranging from 50 to 80 tons. One of these drifts was a veritable mud drift. Consequently the shovel had to move around for ore, had to clean fly-dirt moving in and clean up a heading twice and sometimes three times on a shift, and was frequently out of ore on account of a shortage of drill men.

3. The company was operating at reduced capacity and had contracted to supply a neighboring mine with air and this air was taken from the receiver which supplied the shaft in which the shovel was located. As a result the shovel was frequently without air, or the air pressure was reduced below the point of satisfactory operation.

4. For some time there appeared to be an organized attempt on the part of the men, especially shovelers and trammers, to obstruct the work at the shovel. Discharging men did not seem to cure the situation; besides there was a shortage of men and the mine must be kept in operation. This antipathy is showing signs of being on the wane.

In short, this shovel had to accommodate itself to conditions as they were, and these conditions in every respect were adverse to the shovel. The fact that the rock broke well and made comparatively easy shoveling is the only favorable condition to record.

Much time was lost on account of minor mechanical adjustments and the trial of various suggested changes and improvements.

During the month of August, after the hydraulic pots were changed over by makeshift piping to a mechanical pressure system in closed circuit, the mechanical trouble was greatly reduced. During eighteen shifts operation from July 30 to Aug. 23 (Sundays excluded) the shovel loaded 1,892 tons, or at the rate of 105 tons per shift, with one operator and two trammers moving cans to the lay-by, distance ranging from 40 to 75 ft. Following is the labor cost:

One shovel runner at $4.50	$81.00
Bonus 3c. per can (1,400 lb.) for all over 100 cans	5.30
Two trammers at $3	108.00
	$194.30

1,892 tons at $194.30 = 10.27c. per ton
Average cost hand shoveling = 18.1c. per ton
Saving in labor cost over hand shoveling = 7.83c. per ton

The above takes no account of the cost of air, of oil and grease and of wear and tear. However, under normal conditions, the shovel might be expected to do better. The addition of 4c. per ton would cover the cost of air and a generous depreciation and maintenance charge.

Following is a condensed record of seven carefully made time studies. The last study is particularly interesting, inasmuch as the shovel had been moved to another shaft which had just been opened up in disseminated ground and prepared for more advantageous mechanical loading. Particular emphasis should be laid on the fact that this ore broke quite coarsely, 50 per cent of the rock being between 6 and 12 in. This was the first time I had an opportunity to observe the behavior of the shovel in really coarse rock.

Operating conditions at this shaft will be more favorable. The shovel will have an ample supply of air under good pressure. There are two 72 in. x 18 ft. receivers on the line on the surface and one 30 in. x 10 ft. receiver at the shaft bottom. A New Jersey Meter Co.'s drillometer (registering to 300 cu.ft. per min.) has been installed on the shaft side of the underground receiver. There was no pulsation or surge noted during the heaviest loading; the flow of air through the meter was steady. At no time was the shovel consumption over 125 cu.ft. per minute.

Time Studies

	Aug. 10	Aug. 13	Aug. 14	Aug. 18	Aug. 22	Aug. 23	Sept 9
Total tons loaded during shift	59	114	100	126	156	148	106
Net loading time (N.L.T.) Min.	127	231	182	225	240	226	161
Tons loaded per hour of N.L.T.	27.6	29.5	33	30	39	39	39.5
Delays during loading							
Waiting for cars Min.	7	59	24	60	40	45	5
Laying track Min.	7	.....	...	...	20	...	...
Moving up and transferring							
No. of transfers Min.	.....	.....	1	1	1	1	.....
No. of move-ups	1	6	4	6	7	5	2
Total moving time Min.	6	31	40	55	70	45	15
Pulling down dirt and blasting Min.	.....	22	57	35	30	...	24
Mechanical trouble Min.	8	27	30	...	.....	84	5
Low air pressure (below 50 lb.)	83	33	...	45	25	15	.....
Total delays to loading Min.	157	172	151	195	185	189	49
Gross loading time (G.L.T.) Min.	284	403	333	420	425	415	210
Tons per hour of G.L.T. Min.	20.75	17	18	18	21.5	21	30.5
Reduction of available working time (full shift 480 min.)							
Barring down roof Min.	.....	.....	...	...	.....	...	45
Starting late Min.	72	42	67	25	15	20	15
Extra delay at noon Min.	25	19	39	18	28	15	.....
Quitting early Min.	.....	16	41	7	12	30	.....
Out of ore Min.	99	.....	...	...	.....	...	210
Total reduction Min.	196	77	147	60	55	65	270
Time accounted for Min.	480	480	480	480	480	480	480

Note: Time study of Sept. 9 was taken during first day's operation in a new location and this was the first opportunity the shovel had to show what it could do in rough, blocky loading.

The time study on Sept. 9 represents the first day's run in rough ground. On Sept 10, 11 and 12 the shovel loaded 151, 152 and 160 tons respectively, running out of ore each day.

SOCIETIES, ADDRESSES, AND REPORTS

Steam Shovel Standardization*

A Necessity Where Price of Metal Is Low—Four Types and Sizes Probably Sufficient

BY ROBERT E. TALLY
United Verde Copper Co., Jerome, Ariz.

STANDARDIZATION in industry is a means of simplifying operations and reducing costs.

Standardization in shovel mines consists in selecting the most efficient methods and equipment for the conditions, and the utilization of the same methods and equipment where conditions will permit. Conditions arise justifying the use of different methods and equipment at the same mine, but a large percentage of the yardage at shovel mines occurs under conditions that make standardization advisable. It will never be advisable for all operations to use the same size or the same make shovels, locomotives, cars, or other equipment. Nor can the height of benches or banks, or the methods of drilling and breaking ground, be standardized, except in a broad sense of the term.

There are several more or less equally efficient makes of equipment, and improvements in equipment have resulted largely from competition, making it inadvisable to even consider standardization on any one make.

The character and topography of the ground, and the total and daily yardage and investment requirements are the main factors to be used in determining the size or capacity of the equipment. It would be dangerous to use a small shovel on a high bank. Nor would it be good practice to use a large shovel on a low bank, or large expensive locomotives and cars for small shovels and small yardages.

The height of the bank should be determined by the depth to which the ground can be economically broken and the necessity for control or separation of ore from waste where sorting is essential.

The height of the bank determines the size of the shovel. The width of a cut which a shovel can make at a distance of 8 ft. above the track should approximate the height of the bank. This is equivalent to the total lengths of the boom and dipper stick.

Preparing Ground—Ground may be classed as soft, medium, and hard. The most successful methods for breaking ground are well-drill blasting holes, well-drill holes with toe-hole relievers, toe holes, gopher holes, and T-tunnel blasting chambers. Soft ground requires little or no drilling or blasting. Medium and hard ground may be broken by any of the above-named methods, or by a combination thereof.

A series of tests should be conducted to determine the most economical depth to which the ground can be broken, as well as the best methods of drilling and blasting the ground. Any of the standard well drills are satisfactory. Toe holes may be drilled by any of the standard burley, jackhammer, or water Leyner types of drills. Tests should also be conducted to determine the best types of drills, and the character and amount of explosives to be used.

Size of Shovel—There are two standard types of shovels for mining work, as follows:

1. The 3½ to 6-yd. capacity, commonly termed the railroad type. This is probably the most standard shovel made and the most satisfactory for the average run of work. Probably 75 per cent of the total yardage handled at steam-shovel mines is by this type of shovel. Future experience, however, may prove that a larger shovel will replace this as a standard.

2. The .6 to 8-yd. capacity. This shovel is particularly adapted to thorough-cut work, and for high banks when the character of the ground will permit.

Fuel—The fuel cost per yard, or per shovel or locomotive shift, is the deciding factor in choosing fuel. It is often advantageous to be able to change from one fuel to another in accordance with market conditions. The economy derived from superheaters well warrants the cost of installation.

The electric shovel is being rapidly developed to a high degree of perfection, and is now in strong competition with the steam shovel. Future developments will probably be in favor of the electric shovel.

Trucks—Another recent and important development in shovel work is the caterpillar truck, the use of which minimizes delays, reduces the number of pitmen, and enables the shovel to make a hasty retreat from slides.

Transportation—The size and capacity of locomotives and cars are determined by yardage requirements, distances and grades. The standard types of locomotives are the dinkey, saddle-tank, side-tank, and switcher. They vary in weight from 35 to 125 tons.

Dump cars have capacities ranging from 6 to 30 cu.yd.

Rails should be of sufficient weight, and ties properly spaced, with a view of minimizing maintenance costs, and in order to avoid delays. Poor track causes wrecks, and is false economy.

Satisfactory equipment for average yardages, distances and grades consists of the 80-ton switching type locomotives, 25-yd. dump cars, and 75-lb. rail. Smaller equipment is more efficient for smaller jobs. Equipment should be selected on the basis of the lowest cost per yard mile for the entire yardage, cost to include interest on the investment, depreciation, operating and maintenance costs, and other similar charges.

A large shovel job warrants the purchase of a road spreader, track mover, crane, and other miscellaneous equipment. Small jobs do not warrant this investment.

The benefits of standardization are reduced inventories and the interchangeability of equipment and of operators. It enables the manufacturer to specialize on fewer sizes, to furnish better deliveries, to improve designs, and reduce costs.

A careful study of conditions at shovel mines would, no doubt, show that equipment could be standardized to three, and not to exceed four, different types and sizes. Probably 90 per cent of the large mines could standardize to advantage on one and not to exceed two different types.

The present-day lack of standardization is due in a large measure, not to the fact that the value of standardization has been overlooked, but on account of improvements in shovel design and methods. Further, many of the large mines have been developed from smaller ones, where smaller equipment was most efficient, and such mines, in many cases, have not been warranted in replacing nor able to replace the old equipment.

Standardization practice at shovel and underground copper mines is not only advantageous; it is a necessity. The price of the metal is so low, production costs are so high, and competition is so keen, that the industry must be operated on the most efficient basis possible. Efficiency in this case might be defined as the co-ordination of carefully selected unit standards and satisfactory labor results.

The American Mining Congress is to be congratulated for its splendid efforts to promote standardization. The task is a huge one, and well warranted by the results possible of accomplishment.

*A paper to be presented at the convention of the American Mining Congress, Milwaukee, Wis., Sept. 24-29.

International Conservation of Minerals Desirable

Wasteful Practices Such as Those Followed at Caucasus Properties To Be Avoided

The U. S. Bureau of Mines is deeply interested in the conservation of mineral raw materials, according to C. E. Julihn, who has recently called attention to a need for international conservation illustrated by a particular example: "Manganese, though not extensively used as a pure metal," says Mr. Julihn, "is of enormous importance industrially by reason of its value as a steel alloy and as a reagent for use in the manufacture of steel. These are to be considered distinct and separate uses.

"At present it is not difficult to obtain all necessary supplies of manganese in times of peace, but the known resources of this metal throughout the world are decidedly limited. The United States, though possessing considerable reserves of manganiferous iron ore in the Cuyuna range of Minnesota, has only insignificant resources of the high-grade ore and is therefore dependent upon imports, chiefly from Brazil.

"The known world reserves of high-grade manganese include only four great deposits, those of Brazil, of India, of the Caucasus, and one other more recently discovered on the west coast of Africa. Others still may yet be found, but the conservative management of world industry requires reasonable prudence in the use of what we have without too rash a dependence upon optimistic anticipations. This applies especially to those metals which, like manganese when used as a reagent in steel manufacture, become non-recoverable.

"The Kutais deposits in the Caucasus export about a million tons of manganese ore annually, about 20 per cent of it going to the United States, 40 per cent to Great Britain, and the rest to France, Germany, and Italy. This ore as mined averages 47 per cent manganese, which is a good usable grade. However, the buyers of ore naturally seek to obtain the highest possible grade of material, and so it happens that the trade in the Kutais ore became established on a basis of 52 per cent manganese content. I presume that at the start some exceedingly rich ore was available, as is usually the case with nearly all new deposits, but in the utilization of manganese ore there is no technical basis whatever for requiring it to contain 52 per cent. The 47 per cent average content of Kutais ore as mined should be entirely satisfactory. But the trade requirement as to this particular ore, having been once established, has persisted, and to meet it the producers resort to crude washing operations by which the grade of the product is raised to 52 per cent. In the course of this washing there occurs, as a consequence, a loss of 40 per cent to 60 per cent of the original material, according to J. W. Furness, of Philadelphia, who made a study of the operations. It appears, then, that an improvement of 5 per cent in grade is effected by losing into the streams almost half of the manganese mined, though it should be regarded as a most precious world asset.

"As far as I am aware, there is no international agency concerned with the study and regulation of such matters. No nation or private interest as such is injured by the waste to which I refer. The loss will be born ultimately by civilization as a whole, and perhaps by the next generation rather than by ourselves, but it is hoped that merely calling attention to the facts as stated may lead to some means of remedying the abuse. If so, a precedent might be established for the correction of other practices of the same kind, such as the waste of tungsten. Perhaps, indeed, such an agency, once established, might find means for consideration of other questions that possess even greater international importance.

"The thrifty utilization and equitable distribution of the world's mineral resources is at least a legitimate concern of all its people. It is possible that the international struggles for the possession of raw materials may raise a question at some future time as to whether the posession of mineral resources by a nation shall necessarily create an absolute title to them or whether those resources which constitute the foundations of industry should not be regarded as subject to some measure of international control."

Mississippi Survey Studying State's Hydro-electric Possibilities

The Mississippi Geological Survey, under the direction of E. N. Lowe, State Geologist, and in co-operation with the U. S. Geological Survey, is making topographical maps of the more important stream valleys of the state and investigating present possibilities of hydro-electric power development. The department is also carrying on an independent reconnaisance to determine the water-power possibilities of the minor streams of the state. With the co-operation of the U. S. Bureau of Soils, a soil survey is being made in various counties of Mississippi and a report on the bauxite deposits of the state is being prepared. This report will contain numerous analyses and is now about ready for the printer. It will therefore be available soon.

The Survey has now in press a collection of data on oil and gas prospecting in Mississippi during 1921, 1922 and 1923. This report will include logs of practically all wells drilled within the state during these years. A full report will also be issued on drainage developments.

Educational collections illustrative of the geology and mineral resources of Mississippi are being prepared, with descriptive catalogs, for distribution to high schools.

National Safety Council Will Meet in Buffalo

Elaborate Program for Twelfth Annual Congress—Tillson Chairman of Mining Section

The National Safety Council will hold its twelfth annual congress at the Statler Hotel, Buffalo, N. Y., Oct. 1-5. As usual, the program is divided into many sections, each covering safety work in a separate industrial division. B. F. Tillson, of the New Jersey Zinc Co., will act as chairman of the mining section. The first session of this section will be held on the morning of Oct. 2 and will consider coal topics only. On the following morning there will be addresses on "Safety in Underground Transportation in Metal Mines," the speakers being Byron D. Shove, of Ironwood, Mich.; Russell Paul, Gilman, Colo., and Percy Butler and F. C. Wallower, both of Joplin, Mo. G. J. Johnson, of Lead, S. D., will speak on "Maintaining Interest in Safety at Mines," and Charles L. Jones on "Fighting Mine Fires by Carbon Dioxide in Liquid Form." On the morning of Oct. 4 there will be a round-table discussion of the subject of "Maintaining Safety Interest and Improving Specific Service of the Mining Section."

World Mining Congress in Chile in 1924

Among the projects being discussed in the present session of the Chilean Congress is one submitted by the President for the holding of an International Exposition in 1924, of products related to mining, metallurgy, and nitrate, says R. B. Smith, secretary to the commercial attaché in Santiago. The exposition is intended to include all lines in any way connected with mining industries, such as power machinery in general, electricity in all its applications, mining machinery, means of communication, explosives, metallurgical processes, chemical industries, products of mines and metallurgy, scientific processes, designs, models, photographs, statistics, and other subjects relating to mining and allied industries.

Manufacturers of all countries may enter their products, and public demonstrations and competitive contests will be held. It is reported that considerable interest has been manifested by European firms—particularly English and German—in the carrying out of this project.

Iron and Steel Electrical Engineers to Meet

Apparatus representing what 150 manufacturers have developed for the use of the industries during the last year will be on display at the exposition of the Association of Iron and Steel Electrical Engineers in Buffalo, N. Y., Sept. 24 to 28. The program of the technical sessions has been prepared with a view to imparting to those interested the practical experiences and data obtained by engineers in the field of operation.

MEN YOU SHOULD KNOW ABOUT

J. A. L. Henderson, of London, is in Canada.

L. D. Ricketts was in San Francisco recently.

A. J. Beaudette has returned to Los Angeles from Colombia.

Forbes Rickard has returned temporarily from Mexico to Denver.

Charles A. Mitke, of Bisbee, Ariz., is recuperating from an attack of typhoid fever at Long Beach, Calif.

H. S. Denny has returned to London from a visit of inspection to sundry Canadian mining properties.

Frank W. Royer and **William Burleigh** will be detained another month upon examination work near Idaho City, Idaho.

Walter Fitch, president of the Chief Consolidated Mining Co., attended the silver conference at Reno on Sept. 4 and 5, 1923.

Kirby Thomas, of New York, will examine the Central Copper Co.'s property in Arizona, on behalf of the holding company.

George L. Burland has gone to the asbestos fields of Quebec to carry on research into a wet method for the treatment of asbestos.

N. M. Muir, of Muskogee, Okla., has gone to Silverton, Colo., for a two weeks' trip on mine examination work for New York interests.

W. H. Emmons has returned to the University of Minnesota from the Argentine Republic, where he had been making geological examinations.

Charles L. Bradbury has resigned his position with the American Smelting & Refining Co., and is now acting as shift boss for the Mogollon Mines Co., at Mogollon, N. M.

Captain James Hoatson, vice-president of the Calumet & Arizona Mining Co., is making headquarters temporarily at Warren, Ariz., while recuperating from the effects of a minor operation.

Henry E. Crawford, of the Cinco Minas company, has returned to Los Angeles from El Paso, and will soon depart for Nevada upon an examination trip. He will be accompanied by **E. J. Costello.**

George H. Garrey, who was incapacitated for a month as a result of a fall of twenty-five feet due to a ladder breaking under him in a mine, has resumed his geological examination of mines in the State of Jalisco, Mexico.

John William Holt, an English mining engineer, who has been visiting the northern Ontario gold camps, has returned to England to secure capital for the development of Porcupine and Matachewan properties in which he is interested.

I. C. White, State Geologist of West Virginia, directing the State Survey, and with the co-operation of the U. S. Geological Survey, has just completed the topographical field work of mapping West Virginia on the scale of 1 to 62,500.

C. P. McCormack, formerly mining engineer with the M. A. Hanna Co., has accepted the position of consulting mining engineer with Crowell & Murray, of Cleveland, succeeding **C. F. Jackson.**

Wilbur A. Nelson, State Geologist of Tennessee, has directed the making of an industrial survey of the resources of

Wilbur A. Nelson

that state, which is believed to be the first work of that nature conducted by a state department of geology.

H. C. Miller, assistant petroleum engineer, of the U. S. Bureau of Mines, who has recently been detailed to safety work in the oil fields, is making a study of accident statistics from the files of the California State Accident Commission.

Pentecost Mitchell, of Duluth, Mich., vice-president, and **W. S. Tarr**, Duluth, engineer of construction, of the Oliver Iron Mining Co., have returned from a trip to the Gogebic range, where they examined the Puritan shaft, where serious trouble has developed due to swelling ground.

A. J. Hoskin, acting head of the mining engineering department of the University of Illinois, has returned to the university after five weeks of travel in the West and Northwest. He examined mining properties in the Cascade Mountains of Washington, and in Chaffee County, Colo.

Dr. Charles Camsell, Canadian Deputy Minister of Mines, now in Europe, will make a study of French and German methods of obtaining oil from oil lands the wells of which have ceased to be productive, the process having proved successful when tried out on a large scale in Alsace.

S. R. Zimmerley, formerly a research fellow in the department of metallurgical research of the University of Utah, has been retained by the Department of the Interior to conduct certain research at the Intermountain experiment station of the Bureau of Mines on the thermal decomposition of oil shale. This work has for its object the determination of the rate of formation of oil from oil shale.

O. H. Fairchild, who was in Tokio, Japan, with his wife and daughter, when that city was overwhelmed by the recent disaster, has cabled D. H. Fairchild, "All safe. Pleasanton Hotel, Kobe." Mr. Fairchild went to Japan to erect several units of the Dubbs oil-cracking process for the Nippon Oil Co., of Tokio. The economic conditions created by the earthquake and subsequent catastrophies will probably compel him soon to return to the United States.

W. C. Gordon, of Iron Mountain, Mich., geologist for the Oliver Iron Mining Co., has resigned his position and accepted one with the U. S. Geological Survey, in Washington, D. C. While with the Oliver company Mr. Gordon did important work in tracing the Menominee Range eastward toward Green Bay. He was also in charge of diamond drilling on the Gogebic and Menominee ranges. Previously he was with the Canadian and the Michigan Geological Surveys.

H. Foster Bain, Director of the U. S. Bureau of Mines, has resumed his duties in Washington after an absence of more than two months, during which he assisted the Department of Commerce in its inquiry into nitrate export conditions in Chile. The inquiry in which Director Bain assisted is one of a number of subjects undertaken by direction of Congress to determine the effect of foreign control on commodities for which the United States is largely dependent upon imports for its supply.

MEETINGS

The American Electrochemical Society, of New York City, will meet in Dayton, Ohio, Sept. 27, 28, and 29.

The twelfth annual safety congress of the National Safety Council will be held in Buffalo, N. Y., Oct. 1 to 5, at the Statler Hotel.

OBITUARY

Graham B. Dennis, sixty-eight years old, died of apoplexy at his home in Spokane on Aug. 20. Mr. Dennis had been actively identified with the mining business for the last thirty-eight years, being the original manager of the Old Dominion mine. He was also identified with the Insurgent mine in the Republic district, and mica mines in Latah County, Idaho, as well as many industrial enterprises in Spokane. For many years he was president of the Northwest Mining Association and held that office at the time of his death.

THE MINING NEWS

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Leading Events

MINING MEN from all parts of the country will gather at the National Exposition of Mines and Mining Equipment held at Milwaukee Sept. 24-29, in conjunction with the convention of the American Mining Congress.

The A. S. & R. Co. has completed financial arrangements and has taken active charge of the operations of Compania Metalurgica Mexicana.

The Premier Gold Mining Co. has obtained an additional large block of shares in B. C. Silver Mines, owning adjoining property in British Columbia.

Miners' wages have been raised from $4.25 to $4.75 by the International Nickel Co. at Sudbury, Ont.

A decline of gold output on the Rand for July is ascribed to shortage of labor.

The Anaconda Copper Mining Co. has shut down three copper mines in Butte; six remain in operation.

Three zinc concentrators have resumed operation in the Joplin-Miami district. The rate of output for the district is increasing.

Michigan copper shipments decrease, but curtailed output prevents surplus from accumulating.

The Santa Fe R.R. Co. asks permission to decrease rates on ore and concentrates in Arizona. This will be a material help to small producers.

China will coin its own silver in a new mint at Shanghai.

State officials in Minnesota will collect $5,103,968—and a penalty—on the occupation tax recently declared constitutional.

Premier Gets Another Chunk of B. C. Silver Stock

Recalls Failure to Deal With Selukwe for $1,000,000—May Have Premier Vein

The Premier Gold Mining Co., operating in the Portland Canal district of British Columbia, called a special general meeting of its shareholders for Sept. 17, at Vancouver, to authorize the purchase of 490,349 shares in B. C. Silver Mines, Ltd., and 1,000 shares in Premier Southern. This comprises all the authorized stock in the latter company. The stock under consideration in B. C. Silver is all held in the name of A. W. Witherspoon, John S. W. Pugh, John Speer, Grant Mahood, or Herbert J. Bush.

For some time the Premier company has been trying to obtain a controlling interest in B. C. Silver Mines, which owns ground to both the north and south of the Premier holdings. The Premier company has long owned approximately a one-third interest in B. C. Silver, and about eighteen months ago it made an offer of a million dollars for the balance of the stock, the sum to be payable over two years. The Selukwe company, of London, the holding company for B. C. Silver, turned the offer down, but offered to sell for five million, payable over four years—an offer that the Premier refused to entertain. When the tunnel on B. C. Silver cut what seemed to be the Premier main vein there was a considerable flurry in Selukwe stock, which in a short time quadruple in value, but since has fallen. The price involved in the present transaction is not stated in available reports.

International Nickel Co. Raises Wages from $4.25 to $4.75

May Result in Competitive Raise in Ontario Gold Camps—Cobalt Would Suffer

The International Nickel Co., of Sudbury, Ont., has posted notices of an increase in wages effective Oct. 1. The rate for machine men has been raised from $4.25 to $4.75 a day, and other classes of labor in proportion. This compares with a rate of $4.80 a day for machine men in Porcupine and $4.50 in Cobalt. Though the Nickel company is not short of labor, it is felt that the company would be unable to compete with the gold camps if a shortage does arise, as seems possible, and it also desires to bring back a number of men who left the Sudbury district during the prolonged shutdown.

It is yet too early to make any definite statement, but it is possible that this may result in the gold mines giving an increase, as it is generally conceded that there should be a difference in the rate between Porcupine and Sudbury. If the gold operators should grant an increase as well as Sudbury, the condition created would have an unfortunate effect on Cobalt, where, with one possible exception, operators cannot afford to raise wages.

Anaconda Shuts Down Three Copper Mines at Butte

Part of Plan to Curtail Operating Expense—Miners Find Work Elsewhere

The Anaconda Copper Mining Co., operating at Butte, has closed down the High Ore, Moonlight, and Original mines, leaving six producing properties in operation. This is part of a policy to curtail expenses to the minimum with the copper market in its present condition. A shortage of labor still persists in the district, however, so that all of the miners engaged at the property shut down were able to find work elsewhere. The High Ore mine has the largest pumping plant in the district, and accordingly enough men were retained to keep the plant in operation. This policy on the part of Anaconda is interpreted at Butte as meaning that Anaconda sees no profit in production in Montana with copper under 14c. The current output, together with the receipts from the Chile Copper Co., is apparently ample to take care of the requirements of the American Brass Co. as well as to supply the other fabricating plants belonging to the company.

In addition to the six Anaconda mines, East Butte and Davis-Daly are producing copper and silver ore, and Butte & Superior is hoisting zinc, copper, and silver ore, though at a curtailed rate. The Elm Orlu is mining silver and zinc ore at maximum capacity, shipping zinc concentrate to the electrolytic plant at Great Falls.

Members of the Pan-American Silver Conference grouped before

Among those who attended were representatives from ten states and Mexico. The following is an incomplete list:

Senator Key Pittman, of Nevada.
Senator Tasker L. Oddie, of Nevada.
Senator Frank R. Gooding, of Idaho.
Governor J. G. Scrugham, of Nevada.
P. H. Hunt, manager, Park-Utah Mining Co., Utah.
G. W. Lambourne, president, Park City Mining & Smelting Co., Utah.
E. J. Raddatz, president, Tintic Standard Mining Co., Utah.
James W. Wade, assistant general manager, Tintic Standard Mining Co.
A. G. Mackenzie, director, Montana-Bingham Mining Co., Utah.
H. E. Nyberg, general manager, Dos Estrellos Mining Co., Mexico.
C. E. McMullen, secretary, El Tigre Mining Co., El Tigre, Mexico.
George J. Young, *Engineering and Mining Journal-Press*, San Francisco.
Downie D. Muir, Jr., general manager, U. S. S. R. & M. Co.
John Cortellini, Leadville, Colo.
W. Mont Ferry, manager director, Silver King Coalition Mines Co., Utah.
M. J. Dailey, manager, Silver King Coalition Mines Co., Utah.
F. M. Manson, Western Ore Purchasing Co., Reno, Nev.
Frank M. Smith, smelter director, Bunker Hill & Sullivan company, Idaho.
J. W. Sherwin, general manager, West End Consolidated Mining Co., Nevada.

A.S. & R. Takes Active Charge of Compania Metalurgica Mexicana Operations

Subsidiary Called Towne Mines, Inc.—New Copper Smelter at San Luis Potosi, Part of Program, Begun

THE American Smelting & Refining Co. has taken over the operation of the mines in Mexico formerly owned by the Compania Metalurgica Mexicana. To hold and operate these companies, Towne Mines Incorporated has been formed, a Delaware company.

F. H. Brownell has been elected president of the new company; William Loeb and D. C. Brown have been elected vice-presidents; J. C. Emison has been elected treasurer, and W. E. Merriss, secretary, all being officers of the A. S. & R. Co. except Mr. Brown, who represents Metalurgica interests. The company has outstanding a $100,000 note to the A. S. & R. that takes precedence over other liabilities, and $600,000 in 5 per cent cumulative debentures also issued to the smelting company for money advanced in settling the receivership and rehabilitating the various mines of the company, with $650,000 of debentures in the treasury for issuance as the A. S. & R. makes further expenditures.

The smelting company agrees to set aside 20 per cent of the capacity of the Tecolotes mill for treatment of Santa Barbara ores of the Towne company with 25 per cent of the net earnings from the ore—mining and milling charges at actual cost—as compensation for use of mill, such 25 per cent not to exceed $1.25 per metric ton of ore milled.

The new arrangement assures good management and cheap smelting rates for treatment of ores from the San Pedro, Sombrerete, and Monterey mines. The smelting company gets a 60 per cent ownership in these important properties, easily operated in connection with its other Mexican mines without great increase in overhead or office expense, through advancing approximately $700,000, to be repaid later from profits. In addition it acquires a desirable smelter site at San Luis Potosi that will help greatly in operating its Tiro General mine, at Charcas, at a profit.

Construction of the new copper smelter at San Luis Potosi as agreed with Towne Mines, Inc., has begun. This smelter will have a capacity of 30,000 to 50,000 tons of charge a month, will cost between $1,000,000 and $1,500,000, and should be ready for operation in the fall of 1924, when the A. S. & R. Co. will shut down its Aguascalientes plant, which is getting old and is not so favorably located. The San Luis Potosi smelter will be operated upon silver-copper ores, treating mainly San Pedro and Tiro General output with such custom shipments as may best be handled at that plant.

Work of rehabilitating and preparing for operation the various properties of the Towne company at Santa Barbara has begun. At Sombrerete the mines have been unwatered to a depth of 1,100 ft., and 1,000 tons of fair silver-lead ore a month is being mined from the upper levels and sent to the Asarco plant for treatment. Larger pumping equipment is being installed as fast as possible so as to unwater the mine completely, as at present the two lowest levels are inaccessible.

The San Pedro mines, which have been reopened and producing for about a year, are shipping 1,000 tons of good copper ore a month to the Aguascalientes smelter.

the Mackay School of Mines Building at Reno, Nev., on Sept. 4

H. O. Johnson, superintendent, Tonopah Mining Co., Nevada.
S. S. Carlisle, consulting engineer, Tonopah Mining Co., Nevada.
A. M. Morris, superintendent, Bunker Hill Mining Co., Tombstone, Ariz.
William Loeb, vice-president, American Smelting & Refining Co.
L. E. Hanley, superintendent, Hecla Mining Co., Idaho.
A. H. Burroughs, general manager, Tallache Mines, Idaho.
Robert E. Talley, general manager, United Verde Copper Co., Arizona.
Alfred Harrell, president, California Rand Silver, California.
Oscar Rohn, general manager, East Butte Copper Co., Montana.
A. E. Lowe, manager, North Star Mine, Tonopah, Nev.
William Waters, superintendent, Tonopah Divide Mining Co., Nevada.
W. H. Englebright, superintendent, Consolidated Cortez Silver Mining Co., Nevada.
Frederick Bradshaw, manager, Tonopah Belmont Development Co., Nevada.
E. A. Culbertson, Continental National Bank, Salt Lake City, Utah.
S. F. Booth, Pacific Mail Steamship Co., San Francisco.
E. D. Kracht, Kracht & Murphy, bullion brokers, New York.
C. F. Kelley, president, Anaconda Copper Mining Co.
John Gillie, general manager of mines, Anaconda Copper Mining Co., Butte.
Walter Fitch, Sr., president, Chief Consolidated Mining Co., Utah.
Fred C. Carroll, Ouray, Colo.
Robert M. Betts, manager, Cornucopia Mines Co., Oregon.
George D. Blood, Park-Utah Mining Co.

Calumet & Hecla Proposes to Acquire Manufacturing Facilities

Approval of the Merger Renews Consideration of Plan—No Works to Be Erected at Mines

Approval of the Calumet & Hecla consolidation plan probably will result in the acquisition of a plant for the manufacture of copper and brass products. This policy has been under consideration for some time, hinging upon the success of the consolidation proposal.

There will be no manufacturing at the mines, however. That much has been determined, it being more desirable from economic and marketing considerations to enter into manufacturing in some long-established trade center, where the products can be more easily distributed and where skilled labor is more plentiful.

It is unlikely the matter of manufacture will be given official sanction until production is large enough to warrant acquisition of manufacturing facilities on an adequate scale to permit of economical and profitable operation. The consolidation, just effected, will be a factor in increasing output. With unified operation, the increased elasticity of the available labor and the opportunity of placing and utilizing it to the best advantage will result in a larger and more steady and profitable production.

It is generally understood that when the consolidated company does decide to take up manufacturing it will negotiate for the purchase of one of the large and long-established copper and brass works in a mid-West city.

Surplus Declines, Output Grows, in Joplin-Miami District

A RECENT CHECK showed 126 mines operating in the Joplin-Miami zinc district. This is only a little less than the number operating last May. Production now is around 11,000 tons per week, it having risen from about 9,000 tons in the last three weeks. However, output is still less than sales, and the surplus stocks of zinc ore in the field have steadily been cut down. At present they are estimated to be about 65,000 tons, most of which is held by one concern, the Commerce Mining & Royalty Co.

Amalgamation and Flotation Replace Cyanidation in Ontario Mill

Argonaut, Only Producer in Larder Lake, Mills 60 Tons Per Day in New Plant

The Argonaut Gold Mine, in the Larder Lake district of Ontario, appears to have solved its milling problems. The mill, which has a maximum capacity of about 200 tons a day, was designed to recover the gold by amalgamation and cyanide. The ore carried a considerable amount of copper, and cyaniding was found to be very expensive. Oil flotation at first succeeded in making only about 10 per cent copper concentrate, which was too low for shipment. Experimental work, however, succeeded in raising the grade to approximately 20 per cent, carrying appreciable quantities of gold, and this made a satisfactory shipping product. It has been decided to abandon the cyanide department of the mill and to confine the treatment to amalgamation and flotation, which is making a combined recovery of about 93 per cent from $12 ore. The mill at the present time is treating about 60 tons a day. It is the only one operating in the Larder Lake district.

Santa Fe Would Cut Rates on Ores and Concentrates

THE SANTA FE railroad has applied for permission to grant freight reductions on all concentrate and ore shipments over its lines from all points to the smelter of the Southwest Metals Co., situated at Humboldt, Ariz. If granted, this reduction, which amounts to 50 per cent of the present rates in some cases, will mean a great saving to the many shippers that have their output reduced at the Humboldt smelter.

The Southwest Metals Co. depends entirely on custom ores to supply its furnaces, and recently the plant has been treating ores from over a hundred different sources. The output amounts to about 1,000,000 lb. of copper per month, in addition to the other metals. The majority of producers that will realize a saving in the freight reductions are small operators of northern Arizona.

China Will Coin Own Silver When Mint Is Completed

Plant To Cost $6,000,000 in Course of Construction—Delay Caused by Failure to Pay for Machinery

With the building constructed and the equipment on hand, the completion of the Shanghai mint depends upon China's ability to provide the necessary funds for the installation of the machinery and for the initial operating capital, according to Julean Arnold, of the Department of Commerce. The machinery, which is American, has been held in bond in Shanghai for over a year and is said to be costing the Chinese Government $20,000 a month for storage, insurance, and interest charges. Recent advices state that $1,000,000 of the $2,500,000 needed has already been raised.

The mint is intended to play an important part in the stabilization of China's monetary system and in the establishment of the government's ability to cope with the financial situation in which China is involved.

The program includes the abolition of the tael from the Chinese currency and the adoption of a uniform Chinese silver dollar. The Shanghai mint is to be the central mint and responsible for the maintenance of its standards in the quality of coins minted. It is planned to replace the Mexican dollar, and later the other coins, with these standards, so that gradually China will have in use Chinese and not foreign coins. The central mint is to have a daily minimum capacity of 500,000 silver dollars or a maximum output of 1,000,000 silver dollars a day.

The construction and equipment of the mint, which when completed will represent an investment of about $6,000,000, is in charge of an American.

Cherry Creek, Nev., Mines May Be Reworked

New Company Has Consolidated Old Properties—Treatment Plant Will Be Erected

THE United Imperial Mines Co., a recently organized corporation controlling the Exchequer, Imperial, New Century, Ben Butler, Star, and Mary Ann properties, is planning to build a mill and flotation plant to treat ore from the entire group. The tonnage blocked in each is not sufficient to warrant the erection of a separate mill to treat ores from that particular property.

At the Star is an old cyanide mill, in which there is much machinery that the company will utilize in its new flotation plant. Further, the company has already purchased a large mill in Lincoln County, and the equipment is now being moved to Cherry Creek. Orders have also been placed for a crusher with a capacity of 250 to 300 tons.

Much of the available ore is said to average from $11.37 to $16.75 per ton. The estimated costs for mining milling and treating this ore are said to be about $8.50 a ton.

At the Star mine is an adit tunnel over 4,800 ft. long. The face of this tunnel is within 500 ft. of the Exchequer vein and will be extended to intersect the Exchequer vein as soon as a new compressor and equipment have been installed. This adit tunnel will intersect the Exchequer vein 500 ft. below the present workings in the Exchequer mine. The Imperial mine will also be developed by extending the Star tunnel on the Exchequer vein. This will drain the Imperial and Exchequer mines, thus eliminating the cost of pumping. The Star tunnel is in a position for developing the Grey Eagle mine, which has been taken into the consolidation.

There are two types of ore deposits in the Cherry Creek district. The strong veins represented by the Exchequer and Star, which carry galena and pyrite, are rich in secondary silver minerals. These veins are generally associated with and unquestionably owe their existence to monzonite porphyry intrusions, which, in the case of the veins, occur in the form of dikes.

The Mary Ann is characteristic of another type of deposit—namely, the dissemination of precious minerals within the porphyry. For many years the Mary Ann was considered a vein deposit, the values occurring at the contact of the monolith and the overlying quartzite and shale. More recent development has disclosed that within this monzonite there has occurred contact and regional concentrations of the metallic values, and their location is found to have a definite relation to the position of the overlying quartzite and the shale.

In recent years the mines were operated by leasers, who exhausted every energy to remove what high-grade ore was blocked and immediately available. This procedure resulted in the depletion of the high-grade ore reserves. The high-grade ore that was not chlorided in the early days was picked out by the leasers during the period of high-priced silver.

In the early days, the secondary silver deposits of the district had been pretty well removed and treated in the crude mills of their day. It is interesting to note that the first mill erected in the State of Nevada was constructed at Cherry Creek and operated for years on the ores from Egan Canyon and the Cherry Creek mining districts.

The chlorination process utilized in the early days was not capable of saving the values in the sulphide or more refractory ores, which were encountered in depth as mining operations in the district progressed. Therefore, there are today large accumulations of mill tailings, carrying large quantities of sulphide ores. They range from $8 to $20 a ton in silver-gold-lead content. In 1917 exhaustive tests were made by one of the largest engineering firms in the country in an endeavor to win the sulphide minerals from these tailings as well as from the ores in the blocked reserves within the mines. These flotation tests were highly satisfactory on the sulphide ores and showed extractions of silver to 90 per cent.

The district is reached by the Nevada Northern R.R., and is about 90 miles south of Cobre and 50 miles north of Ely. The town of Cherry Creek is four miles west of the railroad.

Michigan Copper Shipments Dwindle Somewhat

Small Production Prevents Stocks from Accumulating Unduly, However

Copper shipments by boat out of the Michigan district in August were 7,090,000 lb. Of this amount, 5,960,000 lb. was shipped by Calumet & Hecla and subsidiaries from the Torch Lake docks; 660,000 lb. came from the Michigan smelter at Houghton, which handles Copper Range, Mohawk, and Wolverine metal; and 470,000 lb. was shipped by Quincy. Rail shipments during the month brought total deliveries up to approximately 10,000,000 lb.

Boat shipments in August showed an improvement over the July total, which was 5,536,000. Shipments in the first two months of the season of navigation, however, were approximately twice as large as the July figures.

Owing to the general slackening of copper demand, there is some accumulation of metal at the smelters in the Michigan district, but stocks are said to be little larger than are usually carried in normal times. This is a consequence of the diminished rate of production prevailing.

National Exposition of Mines and Mine Equipment To Be Held in Milwaukee Sept. 24 to 29

Will Feature Mining Congress Meeting—Operators Gather from Many States—Practical Program Planned —150 Exhibits Promised

THE twenty-sixth annual convention of the American Mining Congress and National Exposition of Mines and Mine Equipment, which will be held at Milwaukee Sept. 24 to 29, is expected by officials of that organization to be the most successful in its history, largely because of the importance of the topics which will occupy the program.

One of the outstanding features will be the sessions on industrial co-operation under the auspices of the division of the American Mining Congress created for that purpose a year ago and which now has committees functioning in twenty-three states. The exposition will present exhibits from 150 manufacturers and distributors of machinery and mine equipment.

Sessions of the congress and the exposition will be housed at the Milwaukee Convention Hall, which is said to present an ideal arrangement for a meeting of this character, having facilities for sectional meetings which may be held simultaneously and ample display space for the exhibits.

The first general session will begin at 10 o'clock Tuesday morning, Sept. 25. The industrial co-operation division will hold meetings at 2 p.m. with a dinner on the evening of that date, at which Lawrence F. Abbott, president of the Outlook Publishing Co.; E. J. Henning, Assistant Secretary of Labor; J. C. Bradley, of the Elk River Coal & Lumber Co., and former president of the National Coal Association; Cleveland Dodge, of the Phelps Dodge Corporation, and others are scheduled to speak. Problems of the metal-mining industry will be discussed at the first general session on Tuesday morning, and the entire morning session of Friday, Sept. 28, will be devoted to these topics. The fourth National Standardization Conference will be held the entire day on Thursday, Sept. 27, and it is expected that addresses will be made by Warren R. Roberts, Charles A. Mitke, A. W. Whitney, and other mining engineers. The National Tax Conference will have sessions on the afternoon of Sept. 26, 27, and 28, with addresses scheduled from Paul Armitage, Arnold A. Barr, George E. Holmes, H. B. Fernald, and others.

One of the features of the congress this year will be open-forum discussions of particular interest to practical operating men. These will be informal and based on questions submitted.

The annual banquet will be held Friday evening Sept. 28, at the Hotel Wisconsin, at which time it is expected that Senator Shortridge, of California, will speak on "The Proposed Department of Mines"; Senator Lenroot, of Wisconsin, also will make an address; and Governor Scrugham of Nevada will speak on the Colorado River project.

Cornelius F. Kelley, of the Anaconda Copper Mining Co., is scheduled to make an address Friday morning on nonferrous metals. W. Mont. Ferry, of Utah, is scheduled to make an address on "The Future of Silver" during the convention.

Ixtlan del Rio, Nayarit, Center of Mine Development

Railroad Construction Helps District—Mill Possible for Humboldt Mining Co.

BY HENRY MACE PAYNE

The Humboldt Mining Co., at Ixtlan del Rio, Mexico, made its first commercial shipment of ore last week to the Peñoles smelter at Torreon. This company is continuing its crosscut tunnel through Monjaras Mountain, and is also sinking a shaft in the Humboldt vein to intersect the tunnel. When completed the mine will have a capacity of 1,000 tons per day output. Plans are now on foot for a mill to serve this and adjoining properties controlled by the same company.

The Espanola property, operated by T. F. Taylor, of Philadelphia, has concentrated its development on crosscutting three veins which have converged at the head of the tunnel. A mill of five tons' daily capacity, operated by water-power, is being erected on L'Aurora Rancha, adjoining the Espanola. It was at this property that the tunnel broke into old Spanish works in May last, and uncovered more than 10,000 tons of silver ore broken down and sorted ready to carry out. This was good shipping ore.

The Parcioneros Mining Co., is sorting ore and accumulating a shipment to be consigned to the A. S. & R. smelter at Aguascalientes.

The activity caused by the construction of the Sud Pacifico de Mexico between Tepic and La Quemada has made Ixtlan del Rio the distribution point for contractors' and mining supplies. Prospecting and mining are being stimulated. P. G. Holms & Co., of Guadalajara, are building a large warehouse at this point, and repairs are being made to the old military road to permit the passage of automobiles in the dry season, between Tepic and Ixtlan del Rio, and on to the Puerto Zuelo, leaving only the Barrancas de Amejac to be crossed by mules. A regular stage automobile line was established by General Diegas between Tajo, Santa Thomas, and La Quemada in connection with the twice-a-week trains from Orendain, on the opposite side of the Barrancas.

Fate Follows Finder of Fortune in Freezer

ABOUT A YEAR AGO a bar of gold bullion, valued at $2,800, property of the Gold Canyon Dredging Co., near Dayton, Nev., disappeared in transit to the U. S. Mint. After diligent search the bullion was given up for lost. However, it has recently been found and its disappearance explained. It developed that the express messenger had placed the bar in an ice-cream freezer for safe keeping and forgot to remove it when the freezer was taken off at Reno. A dish-washer later discovered the bullion bar and buried it without comment. After a year had elapsed he decided that the disappearance of the bar must have been forgotten; he unearthed it and tried to dispose of it through a pawn broker. The pawn broker notified the police, and the mystery was explained.

Henry Ford Seeks More Iron

Prospects in Northern Michigan — Buys High-grade Mesabi Sinter to Sweeten Imperial Mine Ore

A number of Henry Ford's engineers are now in the Republic field, on the Marquette iron range, in Michigan, making preparations to carry on further exploratory work at the old Riverside mine, which was first opened in the 80's. This property is two miles to the northwest of Republic, close to the Menominee River, and shipped a total of 16,160 tons of iron ore during the period of operations. Nothing has been done there in more than twenty-five years. Ford now has several diamond drills in operation at other points on the Marquette range and several on the Menominee range. Nothing has been given out regarding the results of the drilling.

Ford has shipped about 200,000 tons from his Imperial mine and contracted for the remainder to meet the requirements of the River Rouge furnaces. The Imperial ore, a limonite, is of low grade and is being mixed with sinter from the plant of the Mesabi Iron Co., Babbitt, Minn. Sixty thousand tons of sinter, for delivery this year, was purchased by Ford through the Clement K. Quinn Ore Co., agents for the Mesabi company's product, as was all of the ore bought in the market for Ford.

Spanish Quicksilver Output Declining

Spanish quicksilver production declined in May, according to the Department of Commerce. Abnormal conditions are attributed largely to the occupation of the Ruhr. May output was 1,570 flasks, against 4,380 flasks in April. Production for first five months of year was 21,855 flasks. Stocks at end of May totaled 17,632 flasks.

Minnesota Starts to Collect $5,103,968 Tax and Penalty

Iron Mining Companies Protest Extraction of Penalty for Non-payment Pending Settlement of Suit

The Minnesota State Treasurer has sent notices to twenty-two iron-mining companies demanding payment for the 1921 and 1922 occupational tax. These statements also include the penalties of 10 per cent for failure to report the earnings by Feb. 1, and 10 per cent for non-payment by June 1; also 1 per cent a month additional penalty.

The total tonnage taxable in 1921 was 14,782,626 tons, with a value of $34,129,069, and in 1922 the tonnage amounted 23,337,515 tons, whose taxable value was $50,937,062. The 6 per cent tax on the 1921 production amounts to $2,047,744 and in 1922 to $3,056,224, amounting to a total of $5,103,968, with the penalties amounting to a total of approximately $1,300,000. These taxes are due under the tonnage tax of 1921, and are for a part of 1921 and the whole year of 1922, being 6 per cent on the net profits of the companies.

Litigation to escape the tax was begun before the state could move to collect the tax in January, 1922. The Federal Supreme Court upheld the tax last June. Now the companies claim that because of the restraining order they are not liable for the penalties.

Tonopah Down to Steady Though Diminished Production

Output 40 Per Cent Less Than in May—Tonopah Extension Looks Best

Conditions in the Tonopah district in Nevada apparently are now stable. Production, measured in tons of ore mined or in value of bullion produced, has fallen off probably 40 per cent since the decline in the price of silver due to completion of silver purchases under the Pittman Act. The Tonopah Extension is the only large mine in the camp which has not cut down on tonnage of ore mined. The recent development on the 2,000 level of this mine on the Anchor vein, and the fact that the Murray vein has been traced by winzes practically to the 2,000 level, in ore of good grade, place this company in a strong position as regards the future.

The West End is mining over 150 tons per day, and underground conditions are said to be satisfactory. The Belmont and Tonopah Mining companies are each mining over 100 tons per day. The Halifax, Rescue, Midway, North Star, Montana, and others are shipping irregularly, and their production is not so high as during the first six months of the year.

No new construction is going on in the district. Labor conditions are satisfactory, wages remain $5.75 for miners and timbermen and $5.25 for muckers and helpers, which is a high scale compared to other western mining camps.

Pipe Conveyor Planned for Montana Mine

AN UNUSUAL method of bringing ore down a hillside to a mill has been decided on by the operators of the Elizabeth mine, in the northern part of Montana, according to a dispatch from Butte. The ore, containing silver and copper, is found near the top of a mountain. It has been decided to build a very steep pipe line 1,800 ft. long, and send the ore down through the pipe to the mill, which is in course of construction. The company has a large force of men at work on both the pipe line and the mill.

Michigan Recruits Miners from Mexico, Germany, and Cornwall

Quincy Makes Experiment with Thirty Latin-Americans—Will They Stay When the Thermometer Touches Zero?

Thirty Mexican miners, the first of that nationality to come to the Michigan copper district this year, have arrived in Hancock from Texas to work for the Quincy Mining Co. The men, who have been working in the copper mines of the southwest, are experienced. They are a strong hardy lot and in spite of the cold winter months ahead it is believed they will remain, as they will be employed at good wages, equal to the remuneration received by other classes of miners. Mexican labor is said to be fairly plentiful and no doubt others will follow.

A number of German and Cornish miners are among the immigrants who have arrived in the district within the last few weeks. Most of the men have relatives or friends at the mines and they report others will come to this region as soon as the restrictive immigration regulations permit.

German miners are being attracted to America because of the uncertain conditions in Germany, high cost of living and comparatively low wages there. In Michigan they are provided with modern homes at cheap rental, receive good wages and find living costs reasonable. They also are assured of steady work. Those who have arrived to date are content with conditions and probably will become a fixture in the district. That they have no intention of returning to the Fatherland is shown by the fact the majority of them already have applied for "first papers" for American naturalization.

In Cornwall the depression in tin mining has closed some of the mines. The unemployed miners are seeking out districts in this country where they have relatives or friends and a considerable number have found their way to Michigan. They have invariably proved to be good miners and moreover have the advantage of adding good citizens to the community.

Three Zinc Mills Restarted in Joplin-Miami District

Acme, Empire Development, and Anna Beaver Concentrators Now in Production List

Several concentrators in the Joplin-Miami zinc-lead district have started recently. Among them is the Acme Lead & Zinc Co. plant, now in operation after being down since it was flooded by heavy rains in June. The ground has been cleared of water, and operations are being carried on at 235 ft. This company formerly had two concentrators, but one was destroyed by a wind-storm two years ago and was not rebuilt.

The Empire Development Co. has completed the sinking of a new field shaft on the north part of its lease, and has started its mill in operation after being down since July, at the time of the two-weeks' shutdown observed by almost all the district's mines in the interest of curtailment. A. S. Molacsay is manager.

The Anna Beaver Mining Co. has completed the erection of a derrick and hopper on a new field shaft on the northeastern part of its lease and now has four field shafts in excellent ore. The mill of this company was started in operation only a few weeks ago, but is gradually being pushed into full production.

Calumet & Hecla Consolidated Listed on "Big" Exchange

Old C. & H. Reports $248,325 Profit for Six Months

The Board of Governors of the New York Stock Exchange on Sept. 12 approved the application of the new Calumet & Hecla Consolidated Copper Co. to list its $50,137,550 capital stock, consisting of 2,005,502 shares of $25 a share par value each. This stock is to be issued in exchange for the outstanding stock of the Ahmeek, Allouez, Calumet & Hecla, Centennial and the Osceola Consolidated mining companies, which have been merged into the new company.

Under the terms of the consolidation 2 68-100 shares of the stock of the new company will be exchanged for each share of Ahmeek stock, 80-100 share for each share of Allouez stock, 1 98-100 shares for each share of Calumet and Hecla stock, 38-100 share for each share of Centennial stock, and 1 56-100 shares for each share of Osceola stock outstanding. The stockholders of the companies have approved the consolidation by a vote of about 88 per cent, the terms being based on an appraisal made by a group of New York engineers.

In an earnings statement issued in connection with the application for listing, the Calumet & Hecla Mining Co. reported net profits of $248,325 for the first six months of the year. The Consolidated company shows total assets of $73,166,915 as of June 30, 1923.

News from Mining Districts

By Special Correspondents in the Field

London Letter

Rhodesian Mining Looks Up—Sundry London Flotations Pending —Abe Bailey Busy

BY W. A. DOMAN

London, Sept. 6—Since the announcement of the settlement between the British Government and the British South Africa Co. quite a fillip has been given to mining business in Rhodesia. By the terms of this agreement the mineral rights were conferred upon the Chartered Company. A few days ago Sir Charles Coghlan, one of the heads of the new local government, speaking at Bulawayo, said it would be the duty of the new government to acquire the mineral rights. Presumably a long period will elapse before the transfer takes place, seeing that the purchase would be a costly matter, and loans have first to be negotiated for capital purposes.

One of the most active personalities in mining in the country is Sir Abe Bailey. With him apparently is working Edmund Davis, and to a certain extent it is said these two are acting in conjunction with the Gold Fields people. I learn that the report made on the Cam & Motor property by Claude Maitland was on behalf of Edmund Davis. It is somewhat doubtful who controls this mine. Lewis & Marks are supposed to have an important interest. The Russo-Asiatic Consolidated bought a large block of shares some months ago, and Abe Bailey lent the company £120,000, getting in consideration therefor 120,000 shares at par. I learn that all the South African houses have representatives in the country investigating various propositions. This is rather strange, as some years ago they overran Rhodesia and turned it down, preferring the Rand, and leaving only the Gold Fields. This house is actively developing the Shamva. It had been suggested in some quarters that the bounds of the orebody were known, though this would not appear to be the case. An incline tunnel is to be sunk to the No. 10 level, 450 ft. vertically below the No. 7. The cost is estimated at £25,000, which will be paid for out of reserves.

Sir Abe Bailey is floating a property called the Sherwood Star, which is reported to be opening up well. The capital is £100,000 in £1 shares, half of which are vendors.

It is said that Chester Beatty is making good progress with his Rhodesian copper properties, and that as soon as the Rhodesian mining market becomes active, he will float one or more companies.

Presumably the Transvaal Silver & Base Metals Co. is exceeding expectations as regards developments. Hitherto the shares have been confined to Johannesburg, and it was understood that they would not be introduced to the London market unless values in the shallow levels were maintained at depth. As particulars have now been registered at Somerset House (London), the inference is drawn that dealings here will soon begin.

Johannesburg Letter

Gold Output Declines with Labor Shortage—Many "Reserves" Under 7 Dwt.

BY JOHN WATSON

Johannesburg, Aug. 14—The Transvaal gold output for the month of July was declared by the Chamber of Mines on Aug. 10 at 754,306 fine ounces, having a value of £3,366,091. The quantity is a decrease of 1,003 oz. compared with June 1, but, owing to a rise of 9d. per fine ounce in the realized price, the July output shows an increase of £4,966 in value. The decreased output is due to a further shortage of native labor on the gold mines, which, at the end of July were employing 4,422 fewer natives than at the end of June.

Thirty-nine gold-mining companies on the Rand have published figures showing their payable ore reserves for last year. Out of this number 21 (or more than half) have reserves which do not contain more than 7 dwt. per ton. These figures emphasize the importance of keeping working costs at a low level.

A report from Salisbury indicates that greater attention is being focused on the potentialities of gold mining in Rhodesia. At the Umfuli Bouket mine (Gatooma district) the first crushing produced 105 oz. gold from 195 tons of ore. At the Iguana mine, in the same district, a reef varying from 24 to 60 in. is said to assay nearly 2 oz. per ton at the 60-ft. level. A new cyanide plant on the Nando claims, near Umsweswe, is now treating (direct) a large lode with satisfactory results. Near Concession Hill, three five-stamp batteries and a Tremain mill are crushing along the strike.

In the Selukwe district, a plant is being erected for the treatment of chrome ore on the Railways Block mine. This plant is for washing the raw product to eliminate impurities and increase the value of the product exported. A Ruston-Hornby gas engine and producer are being used to provide the necessary power.

The West African Diamond Syndicate has been registered, with a capital of £500,000 in £1 shares to take over the Akim Company's diamond interests, which yielded 6,536 carats in 1922.

A new diamond field was proclaimed on farm Holgat No. 104, in the Lichtenburg district, on Aug. 10. The racing line contained 500 optimists, who ran 1,000 yd. before the pegging of claims started.

BURMA

New Products from Namtu Smelter

During the month of August, 20,161 tons of ore was mined by the Burma Corporation, at Bawdwin. A total of 23,370 tons of ore was milled in the treatment plant at Namtu, producing 11,288 tons of lead concentrate; 11,903 tons of lead-bearing material was smelted in the blast furnaces, producing 4,190 tons of hard lead for treatment in the refinery. Refinery products were 3,810 tons of refined lead and 434,680 oz. of refined silver. The tonnage milled includes re-treatment of 2,494 tons of tailing.

Of the silver production 19,000 oz. was recovered from treatment of copper matte. The experimental zinc plant produced 940 tons of zinc concentrates, assaying 9.9 oz. of silver, 6 per cent lead, and 48.6 per cent zinc. In addition to the above, 200 tons of antimonial lead was sold and shipped, and 125 tons copper matte produced ready for shipment from the treatment of accumulated smelter byproducts.

INDIA

Nundydroog Gold Mines Profited in 1922

According to the recent report of the Nundydroog Gold Mines, in Mysore, India, 114,980 tons of quartz, 77,000 tons of tailing, and 123,705 tons of slimes were beneficiated during the year 1922, the total production being 62,657 oz. fine gold (almost the same quantity as in the preceding year), of a value of £294,747. The actual realized value shows a falling off of £38,857. The average price obtained for gold in 1922 was 94s. 2d. per oz., whereas in 1921 the price was 106s. per oz. The company has declared a dividend of 10 per cent. The prospects of the mine have been enhanced by the success which has attended the underground development in the last year. High-grade ore has been encountered at the 56th level. The working costs during the year were reduced by 3s. 4d. per ton, from 39s. to 35s. 8d.

Cordoba Copper Prospect Shows Well —Concentrator Designed

Good progress is reported on the copper-bearing property situated in the district of Singbhum, Chota Nagpur, secured recently by the Cordoba Copper Co. The development work during the year 1922 gave good results. The eastern lode has a width of between 30 and 40 in. and a value of over 4 per cent copper, and the western lode has greater width, though with a slightly lower value. The copper belt runs through the entire length of the property for about eight miles, and ore reserves have been estimated at 300,000 tons. The mining work is now concentrated at the Mosaboni mine, where operations are going on for a distance of about half a mile. A concentrating plant will be designed for a capacity of 100,000 tons yearly.

ONTARIO

Tough-Oakes-Burnside Name of Reorganized Company

A special meeting of the shareholders of the Tough-Oakes Gold Mines, of Kirkland, was held in Toronto Sept. 11, for the purpose of ratifying several new bylaws. One of these provided for the purchase of five mining claims in the Kirkland district, and another provided for the changing of the name of the company to the Tough-Oakes-Burnside Gold Mines, Ltd., increasing the capital stock of the company from $3,000,000 to $5,000,000, and making the par value of the shares $1 instead of $5. Another bylaw authorized the sale of the unissued shares of the company, after the increase in capital stock has taken place, at a discount of not more than 55 per cent of the par value. The Tough-Oakes and Burnside properties are controlled by the Kirkland Lake Proprietary, a London company. The company's mill has been ready to run for about a year.

Nipissing Shipped $284,696 in August

During the month of August Nipissing mined ore of an estimated net value of $173,459 and shipped bullion of an estimated net value of $284,696. Silver was estimated at 63¾c. an ounce. The low-grade mill treated 7,153 tons and the high-grade plant 70 tons. The refinery shipped 451,595 ounces of silver. There were no new developments of importance underground during the month, but stoping operations at all shafts continued to be satisfactory.

NEVADA

Cortez Ships Bullion but Fails to State Value

A new vein has been reported in virgin territory on the fourth level Fitzgerald workings of the Consolidated Cortez mine. First samples indicate two feet of 75 oz. ore on the footwall and four feet of 12 oz. ore on the hanging-wall side of the vein. The find is regarded as important by company engineers. Mine and mill are operating smoothly, and regular bullion shipments being made. The metal content of these shipments has not been published. Ore milled is coming from old fills and active stopes.

Mill at Eureka Seems Assured

Financing for the new addition to the mill of the Holly and Bullwhacker mines, at Eureka, is said to be practically assured. The present plant is treating about 40 tons of ore per day, employing gravity concentration and making a fair extraction from oxidized ore. The process for the new 100-ton mill has not been definitely decided on, but it probably will be of the flotation type. Preliminary tests are said to indicate a recovery of 90 per cent from the oxidized ore. If and when the mill is financed, the Holly shaft is to be sunk to the 1,200 level and the orebodies developed at this depth.

ARIZONA

Reduction in Powder Rates Protested

The railroad companies operating in the state have applied to the Arizona Corporation Commission for a rehearing of the rate decision recently rendered in favor of the Apache Powder Co. and traffic associations of the state. The rail representatives also ask that the rate reduction ordered effective Sept. 10 be postponed until Oct. 10. The recent decision in favor of the powder company ordered reductions in freight rates on the shipment of powder from the company's plant at Curtis to all points in the state. These in some cases amounted to over 40 per cent of the existing rates. The commission also ordered a refund of all above the new rates over a preceding period that amounted to a return of several thousand dollars to the shippers.

Plans for Utah's Iron-Ore Industry Near Realization

THE blast furnace and coke ovens of the Columbia Steel Co., at Ironton, Utah, about 50 miles south of Salt Lake City, are approaching completion. It is expected that construction will be finished by the beginning of March and the production of pig iron started. The Pacific Coast is expected to furnish a market. This will mark the completion of the first step in exploiting the iron-ore deposits of southern Utah.

Globe-Miami Leading Copper District

Recently compiled figures show that the Globe-Miami district has more men on the payrolls of its mines and produces more copper than any other district in the state. Jerome is the largest silver producing district in the state, producing over 2,500,000 oz., and the Bisbee district is second. Other statistics made public show that the average monthly output of copper by the largest eighteen operators in the state was 48,546,334 lb. in the first seven months of this year. At that rate, the production for the year should be 582,556,000 lb. The highest production was attained during the year 1918, when the output totaled 769,522,000 lb.

Morning Glory Develops

The Morning Glory, Chris Wilson, manager, is sinking a winze from its tunnel level and has cut the continuation of its vein. Shipping has been discontinued for the present, owing to the low price of copper. It is planned to carry on further exploration by diamond drilling. The mine is at Patagonia.

Black Eagle Shuts Down

Due to the drop in the price of silver, the Black Eagle, at Patagonia, has been closed down. This mine has been a continuous producer of a manganese-silver ore carrying about 20 oz. of silver.

CALIFORNIA

Mammoth Smelter Should Start in November

At present the U. S. Smelting is employing 250 men at its Shasta properties, about equally divided between the mines and the smelter at Mammoth. It is expected to resume smelting in November.

Gold Mining Stimulated

Greater interest is being manifested in gold-mining districts. This is due to the situation developing from the lower price of silver, and some silver miners are turning their attention to gold mining. As an example, the Ben Hur Mining Co., of Tonopah, Nev., has bonded the Ben Franklin group of claims near Grass Valley, Calif. The property is an old one and will be cleaned out preparatory to exploration. J. M. Fink is reported to have bonded West Extension claims close to Grass Valley. The Alcade is operating on a three-shift basis and plans to add more stamps.

IDAHO

Tamarack & Custer Will Enlarge Mill

An addition to its concentrating mill, now having a capacity of about 300 tons daily, has been authorized by the directors of the Tarmarack & Custer Consolidated Mining Co., of the Coeur d'Alene. This action is in anticipation of the completion of a crosscut from the old workings of the Greenhill-Cleveland, which will provide an outlet on Canyon Creek through what has been known as the Mammoth No. 6 tunnel. The portal of the tunnel is a short distance above the mill. The new outlet is expected to make possible an important increase in the volume of ore handled and the discontinuance of the rope tramway. A dividend of 2c. a share was declared, payable Oct. 1 to all stockholders on record Sept. 20. The total amount is $100,000.

Clarksfork Properties Develop

Increased development work is bringing the Clarksfork district to the front. A car of ore has been shipped from the Lawrence mine, one-half mile northeast of Clarksfork. Under direction of Joe Reed, manager, several hundred feet of tunnels have been driven and a small mill has been erected.

Two shifts are busy at the Lucky Strike mine, under direction of Jack Webb. More than 1,000 ft. of tunnel has been completed at the West Point mine. Considerable building has been completed, including bunk houses and homes for employees and officials.

Sidney Mine Has Oreshoot

Development of the Sidney mine, in the Pine Creek district, is being directed by F. W. Callaway. Since cutting the orebody on the present level, drifts have been extended 110 ft., all in ore averaging 5 ft. in width. Assays show 23 per cent zinc, 11½ per cent lead, and 5 oz. silver.

THE MARKET REPORT

Daily Prices of Metals

Sept.	Copper, N. Y. net refinery*	Tin		Lead		Zinc
	Electrolytic	99 Per Cent	Straits	N. Y.	St. L.	St. L.
13	13.375@13.50	40.75	41.25	6.85	6.70@6.75	6.45@6.50
14	13.25 @13.50	40.50	41.00	6.85@7.00	6.70@6.75	6.40@6.45
15	13.25@13.375	40.50	41.00	6.85@7.00	6.70@6.75	6.40@6.45
17	13.25	40.50	41.00	6.85@7.00	6.70@6.75	6.40
18	13.125@13.25	40.875	41.375	6.85@7.00	6.70	6.40
19	13.00@13.125	41.00	41.50	6.85@7.00	6.70	6.40
Av.	13.271	40.688	41.188	6.913	6.717	6.421

*These prices correspond to the following quotations for copper delivered: Sept. 13th, 13.625@13.75c.; 14th, 13.50@13.75c.; 15th, 13.50@13.625c.; 17th, 13.50c.; 18th, 13.375@13.50c.; 19th, 13.25@13.375c.

The above quotations are our appraisal of the average of the major markets based generally on sales as made and reported by producers and agencies, and represent to the best of our judgment the prevailing values of the metals for deliveries constituting the major markets, reduced to the basis of New York cash, except where St. Louis is the normal basing point, or as otherwise noted. All prices are in cents per pound. Copper is commonly sold "delivered," which means that the seller pays the freight from the refinery to the buyer's destination.

Quotations for copper are for ordinary forms of wire bars, ingot bars and cakes. For ingots an extra of 0.05c. per lb. is charged and there are other extras for other shapes. Cathodes are sold at a discount of 0.125c. per lb.

Quotations for zinc are for ordinary Prime Western brands. Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

The quotations are arrived at by a committee consisting of the market editors of *Engineering and Mining Journal-Press* and a special representative of the Bureau of Mines and the Bureau of Foreign and Domestic Commerce.

London

Sept.	Copper			Tin		Lead		Zinc	
	Standard		Electrolytic						
	Spot	3M		Spot	3M	Spot	3M	Spot	3M
13	63	63¾	68¾	195⅞	196¾	25¾	25¼	33⅝	33
14	62¾	63⅜	68½	193½	194⅝	25⅜	25⅜	33⅛	32⅜
17	62⅜	63⅛	68	193½	194½	25⅝	25⅛	32⅞	32⅜
18	62⅛	62¾	67¾	197¼	197¾	25⅜	25	32¾	32⅜
19	62⅛	62¾	67½	198⅛	198¾	25⅜	24⅞	33⅛	32½

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver, Gold, and Sterling Exchange

Sept.	Sterling Exchange "Checks"	Silver		Gold London	Sept.	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
13	4.54	64⅛	31 11/16	90s 8d	17	4.53⅞	64⅜	31⅞	90s 9d
14	4.53¾	64⅛	31¾	90s 10d	18	4.53½	64⅜	31 13/16	90s 9d
15	4.53¾	64⅛	31 11/16	.....	19	4.53½	64⅝	31 15/16	90s10d

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London silver quotations are in pence per troy ounce of sterling silver, 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command one-quarter of a cent premium.

Metal Markets

New York, Sept. 19, 1923

The non-ferrous metal markets have had an unsatisfactory week so far as copper and zinc prices are concerned. Copper prices dropped to new lows for the year; and zinc is easier owing to the absence of good buying from the galvanizing industry. The lead market is strong, and sales of that metal continue to be made in large volume. The London market has declined almost daily in these metals, so that the declines in this market may be partly attributed to the weaker position abroad. Europe's political ailments are doubtless at the root of the whole matter.

Copper

The market was fair earlier in the week, when sales were made at prices ranging as high as 13⅜c. delivered. Since Monday, however, the market is distinctly lower and has fallen off each day. One producer, after failing to interest consumers at prices as low as 13⅜c. delivered, succeeded in selling a heavy tonnage today at 13¼c. delivered. This has placed him out of the market for the time being. Other producers are asking higher prices, but are not reporting much business. The largest producers are not following the market down, as they feel that nothing is to be gained by cutting prices. On the contrary, they believe that what little consuming demand there is may be scared away by the falling prices. It is felt in the trade that production is at too high a rate considering the condition of the market during the last few months.

Except for the announcement that a few of the Butte mines are shutting down, no other copper-mining district shows a tendency to retard production. Consumption of copper by domestic consumers is satisfactory according to statistical compilations, and the margin of stocks in the hands of consumers is small. One of them states that he has not yet ordered his requirements for October. If this be the general practice, there should be a scramble for the metal so soon as the price curve turns the corner. Copper seemingly cannot get away from the sharp fluctuations upward or downward that characterize the market.

Export business has been the bright spot for the week, with some large sales to European and Far Eastern buyers. One producer reports being able to sell chiefly in Europe during the week, where a market was nearly always open, whereas in the domestic market it has been difficult to interest consumers.

Lead

The American Smelting & Refining Co. advanced its official contract price from 6.75c. per lb. to 6.85c., New York, on Sept. 13th.

The market in New York rose during the week, whereas that in St. Louis showed a slightly softer appearance. Spot tonnages in New York command a price of 7 to 7.10c. per lb. October lead is available at 6.85c. In St. Louis sales were made earlier in the week at 6.75c. per lb., but today the common grades can be readily obtained for 6.70c. per lb. In both markets inquiry was splendid, and prices might have moved to higher levels were it not for the weaker tendencies in the sister non-ferrous metals, which acted somewhat as a damper. The drop in the London market may have the effect of releasing Mexican lead in the American markets. The paint manufacturers report a slackening in the production of pig-

ments. This decrease is, however, offset by the decline in lead production attendant upon cessation of the Pittman Act silver purchases, which indirectly affected it.

Zinc

On last Thursday unusually large sales were made. One company alone sold over 800 tons of Prime Western slab zinc, but at concessions under the previous day's prices. Sales since then have been light. A small export order was taken yesterday. Today the metal is freely offered at 6.40c., East St. Louis. In zinc as in the other metals the London market has been watched closely. Some of the producers who purchased heavily in the Joplin ore market a few weeks ago will not be able to make a profit in the present Prime Western market. High-grade sales have been good at unchanged prices—8 to 8¼c. per lb. New York zinc is 35 points above St. Louis. Forward metal commands a slight premium, from 2½ to 5 points for October delivery on Sept. 13.

Tin

The market has relapsed into a state of quietness with little activity shown by dealers or consumers. Electrolytic tin is being shipped by its producer in this country only against previous orders. No additional first-hand supplies are available.

Arrivals of tin in long tons: Sept. 12th, China, 75; 13th, Straits, 50; 14th, China, 25; 17th, Liverpool, 165, Straits, 550.

Foreign Exchange

The market was quiet during the week. On Tuesday, Sept. 18, francs were 5.76c.; lire, 4.39c.; Canadian dollars, 2$\frac{1}{32}$ per cent discount.

Silver

Prices have continued to advance on the strength of further orders from the Indian bazaars, and the market appears steady in spite of sales abroad on the part of China. A new high level on this movement was reached on Sept. 19.

Mexican Dollars — Sept. 13th, 48⅞; 14th, 48⅞; 15th, 48⅞; 17th 49⅛; 18th, 49⅛; 19th, 49¼.

Other Metals

Quotations cover large wholesale lots unless otherwise specified.

Aluminum—99 per cent grade, 25@27c. per lb.; 98 per cent, 25@26c. London, £115.

Antimony — Chinese and Japanese brands 7½c. W.C.C. brand, 8½c. Cookson's "C" grade, 10.25@10.50c.

Bismuth—$2.55 per lb. London, 10s.

Cadmium—$1 per lb. London, 4s. 6d.

Cobalt—$3 per lb. for spot.

Iridium—$275@$300 per oz.

Nickel—27@32c. per lb. for 99 per cent virgin metal. London, £125@£130 long ton.

Palladium—$80 per oz.

Platinum—$116 per oz. London, £24 15s.@£25.

Quicksilver—$63 per 75-lb. flask. Quiet. San Francisco wires $61.35. London, £8¾.

The prices of **Magnesium, Molybdenum, Monel Metal, Osmium, Radium, Rhodium, Selenium, Tellurium, Thallium,** and **Tungsten** are unchanged from prices given Sept. 8.

Metallic Ores

Chrome, Iron Ore, Magnetite, Manganese, Molybdenum, Titanium, Tungsten, Vanadium, and **Zircon Ore** are unchanged from the quotations published Sept. 8.

Zinc and Lead Ore Markets

Joplin, Mo., Sept. 15—Zinc blende, per ton, high, $43.10; basis 60 per cent zinc, premium, $41; Prime Western, $40; fines and slimes, $39@$37; average settling price, all zinc ore, $41.

Lead, high, $86.90; basis 80 per cent lead, $86; average settling price, all lead ores, $83.27 per ton.

Shipments for the week: Blende, 14,688; lead, 863 tons. Value, all ores the week, $674,060.

The shipment was 1,100 tons more than the production, and the purchase was approximately equal to the production. Sellers assert that stocks have been reduced 40 per cent by the restriction policy being pursued, and it is the purpose to hold together and wipe out all excess stocks at the mines by the end of the year.

Platteville, Wis., Sept. 15—Blende, basis 60 per cent zinc, $43 per ton. Lead, basis 80 per cent lead, $85 per ton. Shipments for the week: Blende, 455 tons; lead, none. Shipments for the year: Blende, 21,818; lead, 530 tons. Shipments for the week to separating plants, 643 tons blende.

Non-Metallic Minerals

Asbestos—Crude No. 1, $375@$500; No. 2, $250@$300; spinning fibers, $150@$200; magnesia and compressed sheet fibers, $90@$135; shingle stock, $50@$65; paper stock, $35@$40; cement stock $20@$25; floats, $8@$15. All f.o.b. mines, per short ton, Quebec.

Barytes, Bauxite, Beryl, Borax, Chalk, China Clay, Diatomaceous Earth, Emery, Feldspar, Fluorspar, Fuller's Earth, Garnet, Graphite, Gypsum, Limestone, Magnesite, Manjak, Mica, Monazite, Phosphate, Pumice, Pyrites, Silica, Sulphur, Talc and **Tripoli** are unchanged from the Sept. 8 prices.

Mineral Products

Arsenic — The market is 11c. per lb. for all positions through next March.

Copper Sulphate—5.10@5.25c. per lb., domestic product.

Sodium Nitrate—$2.45 per 100 lb., ex vessel, Atlantic ports.

Potassium Sulphate and **Sodium Sulphate** are unchanged from quotations of Sept. 8.

Ferro-Alloys

Ferrosilicon—50 per cent, $85.

Ferrotungsten—88@95c. per lb. of contained W, f.o.b. works.

Ferrocerium, Ferrochrome, Ferromanganese, Ferromolybdenum, Ferrotitanium, Ferro-uranium and **Ferrovanadium** are unchanged from the prices published Sept. 8.

Metal Products

Copper—Sheets, 22¼c. base; wire, 16@16¼c.

Nickel Silver—18 per cent Grade A sheets, 28½c.

Yellow Metal — Dimension sheets, 19½c.; rods, 16½c.

Zinc Sheets—Base price, $9.25 per 100 lb., f.o.b. plant.

Lead Sheets—Cut, 10.25c.; full 10.50c. per lb.

Refractories

Bauxite Brick, Chrome Brick, Firebrick, Magnesite Brick, Magnesite Cement, Silica Brick and **Zirkite** are unchanged from the Sept. 8 prices.

The Iron Trade

Pittsburgh, Sept. 18, 1923

Buyers of steel-mill products have become additionally conservative, apparently being disappointed at the plain showing September has made of not bringing an increase in market activity, when during July and August a large increase was predicted. Steel producers insist that there is no occasion for a pessimistic attitude, seeing that deliveries continue to be well taken, indicating that actual consumption requirements continue, and that production has thus far tapered off only a trifle.

The consuming industries in general are running well. The automobile industry is more active than was expected. Oil-country tubular goods have been moving well, but as certain drilling programs have now been completed and winter is approaching a further recession is certain. Merchant pipe demand is heavy, and much more could be sold, for immediate or early shipment, than is available. Nearly all the tin plate that can be produced to Jan. 1 has now been sold, bringing in substantially all cases the full $5.50 price.

There is heavy demand from Japan for sheets of various descriptions, including electrical sheets, and increased demand from South America.

Steel ingot production is running at 40,000,000 tons a year or more, against the peak rate of 49,000,000 tons last April and an average of 32,000,000 tons in the four years 1919 to 1922 inclusive.

Steel prices are firmly maintained all along the line at last April's level.

Pig Iron—Production gradually declines, helping to equalize. Prices have been steady for several weeks at $26.50 for bessemer and $25 for basic, foundry and malleable, at Valley furnaces.

Connellsville Coke — Demand has grown very light and prices are lower: Heating coke, $4@$4.25; furnace, $4.75; foundry, $5.75@$6.25.

Imports of Ores and Metals in July, 1923 and 1922

Imports of ores and metals during July, 1923, with revised comparative figures for July, 1922, as compiled from the returns to the Department of Commerce, were as follows. Figures are in pounds unless others specified:

	July, 1922	July, 1923
Antimony:		
Ore	.....	.....
Metal, matte and regulus	3,634,190	2,540,146
Copper:		
Ore	10,160,583	5,355,859
Concentrates	574,865	3,664,861
Regulus, coarse metal and cement copper	198,892	1,473
Total	10,934,340	9,022,193
Imported from:		
Spain	1,084,057	7,920
Canada	269,421	3,527,652
Mexico	.....	1,925,261
Cuba	.....	2,288,460
Chile	9,144,373	243,198
Colombia	.....	85
Peru	276,110	1,452
Other countries	160,379	1,028,165
Unrefined, black, blister and converter copper in pigs and bars	25,656,776	35,213,686
Imported from:		
Spain	.....	1,158,589
United Kingdom	74,782	476,735
Canada	2,313,490	1,246,046
Mexico	2,869,935	5,27,280
Chile	4,785,258	8,514,299
Peru	10,938,782	10,610,322
Portuguese Africa	4,674,529	4,266,347
Other countries	.....	3,734,068
Refined copper	6,636,860	8,359,579
Old and clippings for remanufacture	591,521	522,634
Composition metal, copper chief value	118,418	238,061
Copper manufactures	.....	11,373
Brass:		
Old and clippings for remanufacture	19,264,819	5,630,584
Manufactures of brass	.....	42,296
Lead:		
Ore and matte	116,167	6,749,828
Bullion or base bullion	9,372,231	11,872,539
Pigs, bars, other forms and old	1,539,422	2,016,872
Manufactures of lead (except type metal)	.....	80,527
	.....	80,527
Manganese ore, long tons { free / dutiable }	70,318	23,824
Pyrites, long tons	31,040	27,844
Tin:		
Tin ore	1,604	126
Tin in bars, blocks and pigs	12,683,135	12,615,879
Imported from:		
United Kingdom	1,465,091	3,348,738
British Straits	10,069,625	7,845,269
China	.....	56,257
Dutch East Indies	391,683	175,241
Hongkong	566,255	1,178,554
Australia	56,000	11,200
Other countries	134,481	620
Tungsten ore, long tons	.....	159,230
Zinc ore (dutiable)	746,358	32,989
Zinc in blocks and pigs, (dutiable)	1,147	9,062
Zinc dust (dutiable)	.....	4,500

French Metal Market Is Quiet

FOREIGN CORRESPONDENCE

Copper—Consumption of copper in France in 1921 was 60,320 tons; it amounted in 1913 to 116,685 tons. In 1922, the consumption increased to 96,390 tons, and is showing a tendency upward owing to the revival of business. It is important to note, however, that Alsace and Lorraine are now included in the French consumption of copper.

The results of experiments recently made in France for the substitution of aluminum for copper have been published, as was information concerning the order placed by the Southern Railways for 2,000 tons of aluminum for the replacing of copper on the company's electrical equipment. The results have been unsatisfactory. The experiments proved that the defects of aluminum counterbalanced its good qualities, and that it could not be employed to the same advantage as copper. As a matter of fact, aluminum wire is lighter than copper wire; but it cannot be given the same section, even when placed in the same conditions. This is caused, first, by the resistance power of aluminum being inferior to that of copper and, second, by the fact that the heating of aluminum is more rapid. As it is, furthermore, much more costly, the expense in using this metal is higher.

In a new and important electrification of small villages in France, copper is being used to a normal extent.

French production in copper amounts only to 3,000 to 4,000 tons, or a small part of France's necessary supplies. The copper beds of Niari (French Congo) are still unproductive for lack of shipping facilities.

There are now numerous and important outlets for the marketing of copper: the electrification of the small villages in France and electrical equipment of railways, the installation of hydro-electric plants; but the necessary supply of copper is already partly covered. Similar works are being started in the colonies; the Trefileries du Hâvre have recently booked an order for 92,400 kilos of copper wire for the General Post Office in Indo-China at 7.03 fr. per kilo. Among these comparatively new openings for copper, there is an amazing development of private wireless installations for which large amounts of copper sheets and wire are necessary; and also an important marketing through the making of art jewelry and articles for decoration which were formerly made out of gold and silver.

Lead—Since the reopening of the Spanish frontier, consumption of lead has been satisfactory. Although there is not much activity to be noted in construction work, there are still great requirements for the reconstitution of the north and eastern devastated regions of France. Lead-covered cables are being utilized by the Post Office for underground installations. One does not know, however, what the future will be for the lead industry. Some recent experiments have proved that iron and steel tubing can replace lead satisfactorily.

Zinc—The market continues to be steady, with prices advancing. The consumption of zinc is still increasing; some of the plants which were closed down during the recent crisis are now busy again. However, shortage of labor prevents these plants from working to efficiency. The Royale Asturienne Co. is planning to reopen the Rochelle Works, which will produce an extra available supply of rolled zinc amounting to 9,000 tons a year.

Exports of Copper, Lead, and Zinc in July, 1923 and 1922

Exports of copper, lead, and zinc during July, 1923, with revised comparative figures for July, 1922, as compiled from the returns to the Department of Commerce, were as follows. Figures are in pounds:

	July, 1922	July, 1923
Copper:		
Ores, concentrates, matte and regulus (copper content)	300	.....
Copper and manufactures of (total)	64,430,580	64,348,525
Refined, in ingots and bars	58,511,062	57,939,820
Exported to		
Belgium	1,935,410	4,108,822
France	16,874,863	11,219,377
Germany	16,738,698	16,729,806
Italy	1,982,729	5,255,260
Netherlands	3,888,195	762,105
Spain	225,491	168,455
Sweden	1,618,392	3,202,535
United Kingdom	5,711,535	7,969,358
Canada	142,346	1,598,248
China	6,384,004	1,658,403
Japan	2,687,980	3,012,504
Other countries	321,419	2,254,947
Old and scrap	96,205	385,700
Composition metal, copper chief value	8,865	36,076
Pipes and tubes	122,745	136,119
Plates and sheets	261,531	499,037
Wire except insulated	762,791	968,635
Insulated wire and cable	717,601	912,879
Lead		
Pigs and bars		
From domestic ore	1,549,553	277,065
From foreign ore	3,646,124	9,826,649
Exported to:		
France	1,848,773	2,352,513
Germany	448,221	1,557,253
Netherlands	.....	448,127
United Kingdom	2,468,415	4,984,654
Other European countries	.....	224,061
Argentina	291,270	.....
Other countries	138,998	66,309
Zinc		
Dross	1,009,777	3,649,516
Spelter		
From domestic ore	8,644,335	1,226,294
From foreign ore	.....	224,000
Total zinc, slabs and blocks, etc	8,644,335	1,450,294
Exported to:		
Belgium	280,273	.....
France	1,915,341	1,232,086
United Kingdom	4,539,600	168,031
Canada	6,010	3,554
China	1,120,035	.....
Japan	562,311	.....
Other countries	220,765	46,623
In sheets and strips, etc	488,547	474,090
Other zinc manufactures	68,779	45,530

MINING STOCKS

Week Ended September 15, 1923

Stock	Exch.	High	Low	Last		Last Div.
COPPER						
Ahmeek	Boston	58	57	58	June 23, Q	$1.50
Alaska-Br. Col.	N. Y. Curb	1⅛	*99	*99		
Allouez	Boston	...	...	*16	Mar. '19	1.00
Anaconda	New York	43	39½	39½	Se.15, Oc.22, Q	0.75
Arcadian Consol.	Boston	2	1¾	1¾		
Ariz. Com'l	Boston	9⅛	8	9¼	July '23,	0.50
Calaveras	N. Y. Curb	...	...	2		
Calumet & Arizona	Boston	48	45½	47	June '23,	1.00
Cal. & Hecla (New)	Boston	41¼	40	40	June '23, Q	10.00
Centennial	Boston	...	...	7	Dec. '18, SA	1.00
Cerro de Pasco	New York	41⅜	39	39¼	Jy. 19, Au. 1	1.00
Chile Copper	New York	27⅛	26½	26½	Se. 1, Se. 29, Q	0.62½
Chino	New York	18	16½	16½	Sept. '20, Q	0.37½
Con. Cop. Min. (New)	N. Y. Curb	2½	1⅝	2		
Copper Range	Boston	30	26½	26½	May '23, Q	1.00
Crystal Copper	Boston Curb	60	58	58		
Davis-Daly	Boston	3	2⅜	2⅛	Mar. '20, Q	0.25
East Butte	Boston	5⅜	5	5	Dec. '19, A	0.50
First National	Boston Curb	40	35	35	Feb. '19, SA	0.15
Franklin	Boston	1½	1½	1⅜		
Gadsden Copper	Boston Curb	55	50	55		
Granby Consol.	New York	20	17	17	May '19, Q	1.25
Greene-Cananea	New York	21	19	19	Nov. '20, Q	0.50
Hancock	Boston	1⅛	1¼	1½		
Howe Sound	N. Y. Curb	3	2⅜	2⅜	Jy. 2, Jy. 16	0.05
Inspiration Consol.	New York	30¼	27½	27½	Se.13, Oc.1 Q	0.50
Iron Cap	Boston Curb	4¼	4¼	4¼	May 23, K	0.15
Isle Royale	Boston	22½	20	20	Se. 1, Se. 15,	0.50
Kennecott	New York	35¼	33½	33⅞	Se. 7, Oc. 1,	0.75
Keweenaw	Boston	*77	*75	*77		
Lake Copper	Boston	2	1⅜	1⅜		
Magma Copper	New York	31½	29½	29½	Jan. '19, Q	0.50
Mason Valley	N. Y. Curb	1⅞	1⅞	1⅞		
Mass Consolidated	Boston	1¼	1⅛	1¼	Nov. '17, Q	1.00
Miami Copper	New York	24⅜	23	23	Se. Oc.1, Q	0.50
Michigan	Boston	2⅛	2	2⅛		
Mohawk	Boston	42⅜	39½	40½	Se. 22, Oc. 13,	1.00
Mother Lode Coa.	New York	9⅜	8⅛	8½	Je. 8, Je. 30, Q	0.50
Nevada Consol.	New York	12⅜	12	12⅜	Sept. '20, Q	0.25
New Cornelia	Boston	18½	17½	17½	Au. 3, Au. 20, Q	0.25
North Butte	Boston	2⅜	1⅞	2	Oct. '18, Q	0.25
Ohio Copper	N. Y. Curb	*70	*61	*65		
Old Dominion	Boston	17½	17	17	Dec. '18, Q	1.00
Osceola	Boston	31⅜	31½	31½	June '23, Q	1.00
Phelps Dodge	Open Mar.	†160	†150	...	Se. 20, Oc. 2 Q	1.00
Quincy	Boston	28	25	25	Mar. '20, Q	1.00
Ray Consolidated	New York	11⅜	10½	10½	Dec. '20, Q	0.25
Ray Hercules	N. Y. Curb	*63	*60	*63		
St. Mary's Min. Ld.	Boston	36	36	36	Mar. '23, K	3.00
Seneca Copper	New York	9⅜	8	8⅛		
Shannon	Boston	*50	*50	*50	Nov. '17, Q	0.25
Shattuck Arizona	New York	6	6	6	Jan. '20, Q	0.25
South Lake	Boston	...	...	*98		
Superior & Boston	Boston	1½	*95	1½		
Tenn. C. & C. cfs.	New York	9⅝	9⅛	9⅛	Se. 29, Oc.15, Q	0.25
Tuolumne	Boston	1⅛	1	1	May '13,	0.10
United Verde Ex	N. Y. Curb	30	29	29	Oc. 5, No.1, Q	1.00
Utah Consol.	Boston	...	...	1½	Sept '18,	0.25
Utah Copper	New York	63⅜	59	59	Se.14, Se.29, Q	1.00
Utah Metal & T.	Boston	*51	*51	*51	Dec. '17,	0.30
Victoria	Boston			*75		
Winona	Boston	*70	*50	*50		
Wolverine	Boston	7	6½	6½		
NICKEL-COPPER						
Internat. Nickel	New York	12⅞	12	12	Mar.' 19,	0.50
Internat. Nickel pfd.	New York	78	77	77⅛	Jy. 19, Au. 1	1.50
LEAD						
Carnegie Lead & Zinc	Pittsburgh	3⅛	3⅛	3⅛		
National Lead	New York	130⅜	118	118	Se.16, Se.29 Q	2.00
National Lead pfd.	New York	112⅜	112⅛	112⅛	Au. 24, Se.15 Q	1.75
St. Joseph Lead	New York	20	19	19	Se.9, Se.20 Q, X	0.50
ZINC						
Am. Z. L. & S.	New York	9¼	8⅛	8⅛	May '20,	1.00
Am. Z. L. & S. pfd.	New York	32⅛	32	32	Nov. '20, Q	1.50
Butte C. & Z.	New York	6	5⅛	5⅛	Mar. '23,	0.50
Butte & Superior	New York	16½	14	14	Je. 15, Je. 30, Q	0.50
Callahan Zn-Ld	New York	5⅛	5	5⅛	Dec. '20, Q	0.50
New Jersey Zn.	N. Y. Curb	150⅛	150	150⅛	Jy.31, Au.10 Q	2.00
United Zinc	N. Y. Curb	...	...	*50		
Yellow Pine	Los Angeles	*65	*65	*65	June '23, Q	0.03
SILVER						
Alvarado	N. Y. Curb	...	...	2⅛		
Batopilas Mining	New York	⅜	¼	⅜	Dec. '07, I	0.12½
Beaver Consol.	Toronto	*34	*32	*32⅛	May '20, K	0.03
Candelaria	N. Y. Curb	*6	*5	*5		
Castle-Trethewey	Toronto	*30	*26	*28		
Coniagas	Toronto	2.60	2.55	2.60	May '21, Q	0.12½
Crown Reserve	Toronto	*60	*58	*58	Jan. '17,	0.05
Hilltop-Nev.	N. Y. Curb.	*10	*6	*7		
Kerr Lake	N. Y. Curb	2¼	2⅛	2⅛	Oc. 1, Oc. 15, Q	0.12½
La Rose	Toronto	*29	*27⅜	*28⅛	Apr. '22,	0.10
McKinley-Dar.-Sav.	Toronto	*16	*16	*16	Oct. '20, Q	0.03
Mining Corp. Can.	Toronto	3.35	2.70	3.35	Sept. '20, Q	0.12½
Nipissing	N. Y. Curb	5⅛	5⅛	5⅛	Jy. 1, Jy.20 Q	0.15
Ontario Silver	New York	4	3⅞	3⅞	Jan. '19, Q	0.50
Temiskaming	Toronto	*37	*36½	*37	Jan. '20, K	0.04

Stock	Exch.	High	Low	Last		Last Div.
GOLD						
Alaska Gold	New York	...	...	1⅛		
Alaska Juneau	New York	⅜	⅜	⅜		
Boundary Red M.	N. Y. Curb	...	...	*12		
Carson Hill	Boston	5⅛	5	5		
Cresson Consol. G.	N. Y. Curb	5⅜	3⅜	3½	July '23	2.00
Dome Mines	New York	38½	36½	37	Je.30, Jy.20 Q	1.00
Golden Cycle	Colo. Springs	1.06	1.06	1.06	Dec. '22, Q	0.02
Hollinger Consol.	Toronto	11.75	11.50	11.50	Se.15, Oc.5, M	0.05
Homestake Mining	New York	62	62	62	Se.20, Se.25 M	0.50
Kirkland Lake	Toronto	*40	*34	*36		
Lake Shore	Toronto	3.45	3.37	3.40	Au.1 Au.15	23, Q 0.02
McIntyre-Porcupine	New York	16⅛	15⅛	15⅛	Au.1, Se.1, Q	0.25
Portland	Colo. Springs	...	...	*38½	Oct. '20, Q	0.01
Teck-Hughes	N. Y. Curb	1 5/16	1 1/16	1⅛		
Tom Reed	Los Angeles	*55	*52	*52	Dec. '19,	0.02
United Eastern	N. Y. Curb	1 11/16	1 1/16	1 11/16	Jy. '28, Q	0.15
Vipond Cons.	Toronto	*76	*73	*75		
Wright-Hargreaves	Toronto	3.30	2.95	2.95	Se.15, Oc.1, Q	0.02½
Yukon Gold	N. Y. Curb	1¼	1¼	1¼	June '18,	0.02½
GOLD AND SILVER						
Boston-Mont. Corp.	N. Y. Curb	*13	*12	*12		
Con. Cortez	N. Y. Curb	*73	*40	*44		
Con. Virginia	San Francisco	...	...	10½		
Continental Mines	N. Y. Curb	5⅛	5¼	5¼		
Dolores Esperanza	N. Y. Curb	1¼	*85	*85	Jy. 1, Jy.10 Q	0.05
Jib Consol.	N. Y. Curb	...	...	*65		
Tonopah Belmont	N. Y. Curb	*67	*57	*57	Apr. '23, Q	0.05
Tonopah Divide	N. Y. Curb	*50	*48	*48	May 23	0.10
Tonopah Extension	N. Y. Curb	2 1/16	1 15/16	2 1/16	Se. 10, Oc. 1	0.05
Tonopah Mining	N. Y. Curb	...	...	1 1/16	Apr. '23, Q	0.07½
Unity Gold	N. Y. Curb	3⅛	3⅛	3⅛		
West End Consol.	N. Y. Curb	*81	*77	*77	Mar. '23, Q	0.05
SILVER-LEAD						
Bingham Mines	Boston	...	...	16½	Sept. 19, Q	0.25
Cardiff M. & M.	Salt Lake	*91	*53	*86	Dec. '20,	0.15
Chief Consol.	Boston Curb	3⅜	3⅜	3⅜	Au. 1, '23, Q	0.10
Columbus Rexall	Salt Lake	*44	*42½	*44	Aug. '22,	0.03
Consol. M. & S.	Montreal	27	25¾	25¾	Oct. '20, Q	0.62½
Erupcion	Boston Curb	2⅛	2¼	2¼	Se. 15, Oc. 2	0.125
Federal M. & S.	New York	10	10	10	Au. 25, Se. 15	1.75
Federal M. & S. pfd.	New York	41⅛	38½	38½	June '23, Q	1.75
Florence Silver	Spokane	19½	18	18½	Apr. '19, Q.X	0.01½
Hecla Mining	N. Y. Curb	7⅛	7	7	Au.15, Se.15	0.15
Iron Blossom Con.	N. Y. Curb	*32	*32	*32	July 16,	0.02½
Marsh Mines	N. Y. Curb	*7	*7	*7	June '21, I	0.02
Park City	Salt Lake	....	....	2.90	Se.15, Oc.1 Q	0.12½
Park Utah	N. Y. Curb	....	....	3	Je.15, Jy.2 Q	0.15
Prince Consol.	Salt Lake	...	...	*1	Nov. '17,	0.02½
Silversmith	Spokane	*37	*35	*37	Jy. 2, Jy. 10	0.02
Simon Silver-Lead	N. Y. Curb	....	....	*15		
Snowstorm Silver-L.	N. Y. Curb			*43		
Tamarack-Custer	Spokane	1.25	1.25	1.25	Je.30, K	0.02
Tintic Standard	Salt Lake	3.15	3.05	3.15	July '23	0.15
Utah-Apex	Boston	3⅛	3	3	June '23, Q, X	0.50
IRON						
Bethlehem Steel	New York	54½	48½	48½	Se. 1, Oc. 1 Q	1.25
Char. Iron	Detroit	...	...	⅜		
Char. Iron pfd.	Detroit	...	...	1⅞		
Colorado Fuel & Iron	New York	30½	26½	26½	Au. 10, Au.'25 Q	2.00
Col. Fuel & Iron pfd.	New York	...	...	102	Feb.'23, Q	2.00
Gt. North'n Iron Ore	New York	30	29	29	Apr. '23	1.00
Inland Steel	N. Y. Curb	...	...	46½	Au.15, Se.1 '23 Q	0.62½
Mesabi Iron	N. Y. Curb			6⅜		
Replogle Steel	New York	13⅜	11½	11⅝		
Republic I. & S.	New York	50½	43¾	44	May '21	1.50
Republic I. S. pfd.	New York	94	88½	88¾	Se.15, Oc.1 Q	3.75
Sloss-Sheffield S. & I.	New York	49	45	45	Se.2, Oc.1 Q	1.75
Sloss-Shef. S. & I. pfd.	New York			78	Je. 22, Jy. 2 Q	1.75
U. S. Steel	New York	93⅜	87⅝	88⅛	Au.30, Se.29, Q	1.25
U. S. Steel pfd.	New York	117½	116½	117	Au.7, Au.30 Q	1.75
Virginia I. C. & C.	New York	...	...	56½	Je.16, Jy. 2	2.00
Virginia I.C.&C. pfd.	New York	80	80	80	Je.16, Jy. 2	2.50
VANADIUM						
Vanadium Corp.	New York	34½	28¾	29	Jan. '21, Q	1.00
ASBESTOS						
Asbestos Corp.	Montreal	47	44¾	45	Je.30, Jy.15 Q	1.50
Asbestos Corp. pfd.	Montreal	72	70	70	Je.30, Jy.15 Q	1.75
SULPHUR						
Freeport Texas	New York	14⅛	12⅛	13	Nov. '19, Q	1.00
Texas Gulf	New York	58⅛	55⅛	55⅛	Se.1, Se.15 Q	1.50
PLATINUM						
So. Am. Gold & P.	N. Y. Curb	2⅛	2⅛	2⅛		
MINING, SMELTING AND REFINING						
Amer. Metal	New York	45⅜	44½	45¼	Au. 20, Se. 1	0.75
Amer. Metal pfd.	New York	...	...	110	Au. 18, Se 1	1.75
Amer. Sm. & Ref.	New York	60⅜	56¼	56¾	Jy. 9, Au. 1	1.25
Amer. Sm.& Ref. pfd	New York	97½	96½	96¾	Au.10, Se.1 Q	1.75
U. S. Sm. R. & M.	New York	25⅛	23⅛	23½	Jan. '21, Q	0.50
U.S. Sm.R.& M. pfd.	New York	41⅜	41	41	Jy.6, Jy.14 Q	0.87½

*Cents per share. †Bid or asked. Q, Quarterly. SA, Semi-annually. M. Monthly. K, Irregular. I, Initial. X, Includes extra.

Toronto quotations courtesy Arthur E. Moysey; Spokane, Pohlman Investment Co.; Salt Lake, Stock and Mining Exchange; Los Angeles, Chamber of Mines and Oil; Colorado Springs, Colorado Springs Stock Exchange.

NEW MACHINERY AND INVENTIONS

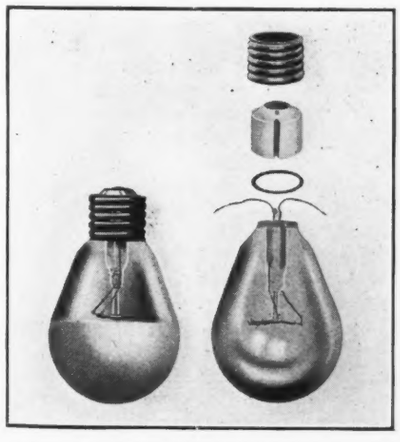
A New Magnetic Separator

The Magnetic Manufacturing Co., Milwaukee, Wis., has designed a new type of magnetic separator, which is of all-metal construction. The frame is of structural steel, firmly bolted and braced, and is so designed as to confine the lines of magnetic force to the point where separation takes place. In this design there are no leaks; that is to say, the steel frame does not in any way effect the magnet nor is the steel frame effected by the magnet. This is known as the Type H separator. It is particularly adapted to separate a wide variety of materials and especially those that are not readily attracted by the ordinary magnet. The magnet in the Type "H'" machine is exceptionally strong as the design allows the use of considerably more wire in the coil windings than in separators of other types. All electrical connections and lead wires are enclosed in an approved metal flexible conduit and all electrical and mechanical parts are readily accessible. Uniform coil windings are provided and the connections made so as to be easily changed.

Type "H" separators are provided with tight and loose pulleys for belting directly to a line shaft, or can be furnished with motors mounted on the separator. Where no direct current is available, a small direct current generator is usually mounted on the machine, all electrical connections being made. A switch panel with electrical instruments is mounted on the separator, thus providing a complete compact unit.

Theft-Proof Electric Bulb

It is estimated that from 15 to 30 per cent of the electric light bulbs used by railroads, industrial plants, hotels, apartment houses, ships, schools, theatres, stores and public places of all kinds are stolen. A theft-proof bulb, designed to prevent all such loss and danger, has been devised by Lester Kulp, 143 W. Austin Ave., Chicago. The remarkable simplicity of the idea particularly recommends it, as there are no guards, locks, keys, springs, or other mechanisms. One contact is at the top just as in an ordinary lamp, as shown in the cut. The other contact is a brass ring, fastened at the bottom of a porcelain plug. This plug has a groove which is filled with plaster of paris, lightly holding the brass shell in place. After the lamp is screwed into the socket, an extra turn breaks the plaster of paris seal, so that the lamp can turn freely in the shell, always maintaining electrical contact. The shell, however, cannot be turned in the socket. The shell being spun over the ring, screws up so close to the socket that fingers or tools cannot grasp it. The lamp positively cannot be stolen or even broken in the attempt to steal it, thus preventing endangering circuits. When the bulb is burned out, it can easily be removed for replacement. The bulbs come in any standard size, voltage or wattage. The lamp is standard in every way.

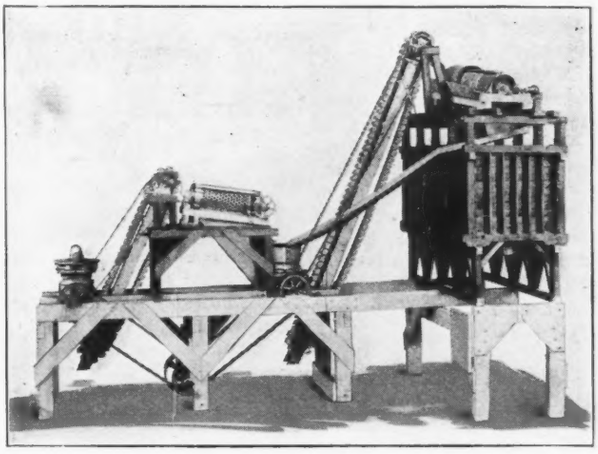


An electric bulb that is hard to steal

INDUSTRIAL NOTES

The Matthiessen & Hegeler Zinc Co. has removed its New York office to Suite 812, Trinity Building, 111 Broadway. John L. Glover, eastern sales manager, is in charge of this office, assisted by William A. Cook.

L. W. Seeligsberg announces that he has established an office at 50 Church Street, New York, for his Industrial Advertising Service.



Telsmith model crushing plant

Telsmith Model Crushing Plant at Milwaukee

The accompanying cut shows the Telsmith model crushing plant which the Smith Engineering Works, of Milwaukee, Wis., will exhibit at the American Mining Congress in Milwaukee, Sept. 24-29. This little outfit is really not a model at all, but an actual operating plant driven by a 1½-hp. motor, reducing granite from 1-in. size down to ¼ in. size and under. The crushing process will be in two steps. A small "edition" of the Telsmith primary breaker will do the coarse crushing. This machine is 12¼ in. in diameter, with 2-in. feed opening and 7 x 2-in. drive pulley. It will be equipped with a complete automatic oiling system, similar to that on the regular Telsmith machines. The coarser rock will be recrushed in a miniature Telsmith reduction crusher to ⅜ in size. This machine is about 10 in. in diameter with 7 x 2-in. pulley and ¾-in. feed opening. This little plant will be equipped with 6 in. scalping and finishing screens and with continuous bucket elevators equipped with 2¼ x 1⅛ x 1½ in. buckets. The bin will be 18 in x 18 in. x 3 ft. 4 in., with bin gates of corresponding size. This model plant may be seen at booth No. 99 in the main exhibition hall of the Auditorium.

Explosive manufacturers have long struggled with the problem of making an explosive which would possess all the advantages of dynamite and at the same time be immune from freezing. Numerous forms of such explosives have been tried in years past, but, as the Atlas Powder Co. claims, the problem has remained unsolved until the development of the new Atlas non-freezing explosive—ammite. In ammite, the manufacturers claim to have produced the ideal non-freezing explosive—an explosive that retains all the advantages of dynamite in strength, velocity, water-resistance, sensitiveness and stability combined with the additional advantages of being non-freezing and of not causing headaches when handled. The manufacturers also recommend Ammite as an all-year-round explosive, on account of its general advantages.

The Scranton office of the Dorr Company, engineers, has been moved to Wilkes-Barre, Pa., 536 Miners Bank Building. The new office is more conveniently located to serve the anthracite field, which is showing an increasing interest in the recovery of fine coal. John Griffin will still be in charge of this branch.

The Westinghouse Electric & Manufacturing Company has issued a new catalogue covering line material and porcelain insulators. The catalogue is supplementary to the company's large supply catalogue and has been issued for the convenience of purchasers of these two allied lines of materials. It has 200 pages.

The Morse Chain Co., Ithaca, N. Y., will have an exhibit, including a full line of chain samples, at the machinery exposition of the American Mining Congress in Milwaukee, during the week of Sept. 24. A 100-hp. silent chain drive will be shown operated by a quarter-horsepower motor with a rotoscope attachment to show the rocker joint action. The display will have much of interest to metal mining men.

Frank E. Shephard, former president of the Denver Engineering Works Co., is now engaged in consulting engineering work, with offices in the Patterson Building, Denver.

George C. Williams, certified public accountant, North Carolina, announces his resignation as assistant chief of the special assessment section, Natural Resources Division of the Internal Revenue Bureau, to assume the duties of manager of the New York office of E. F. Zumwalt, certified public accountant, Oklahoma, counsel in federal tax problems, 15 William St., New York.

The California Cyanide Co. has just purchased sixteen Uehling CO_2 indicating units for its new plant at Huntington Park, Calif. The General Chemical Co. has bought three Uehling CO_2 recorders for its East St. Louis plant; it has three units at its Cleveland plant, two at its Edgewater, N. J., plant and eight units at the Marcus Hook, Pa., plant. The Johns-Manville Co., which has Uehling equipment at its Manville, N. J., plant, has also ordered a five-unit equipment for the new plant at Waukegan, Ill.

The engineering personnel of the Quigley Fuel Systems, Inc., has become associated with the Fuller Engineering Co. and is now in a better position to render more complete engineering services, as by this arrangement designs can be presented from a wider selection of pulverized fuel equipment. In the future all business of the Quigley Fuel Systems, Inc., will be conducted through the main and branch offices of the Fuller Engineering Co.

A five ton metal mining locomotive will be a feature of the General Electric Co.'s exhibit at the American Mining Congress in Milwaukee beginning Sept. 24. Engineers of the company, from Chicago, St. Louis, Milwaukee, Duluth, Schenectady and Erie, Pa., will be in attendance.

The firm of E. D. Bullard will move on Oct. 1 to new quarters at 565 Howard St., San Francisco, Cal. The great increase in business and the number of new appliances, both in the safety first field and in mining, and in foundry specialty supplies, that this company has added to its line in the last year, have made this move necessary. E. D. Bullard, the founder of the business, introduced carbide mine lamps on the coast in the 90's and the firm is still the largest supplier of this commodity in the west. The safety department was added in 1915 under the management of E. W. Bullard, who, since his father's death in 1921, has conducted the entire business. Since 1921 the firm has also added to its line graphite and clay crucibles, used in the large foundries and mines, and lately a special type of metal plug used extensively in oil refinery cracking plants. The Los Angeles Branch of the firm will remain at 130 South Broadway.

The Denver Engineering Works Co.'s line of mining machinery, known under the trade name of Dewco, including electric hoists, mine timber framers, crushing, concentrating and smelting machinery, has been sold to the Stearns-Roger Manufacturing Co., of Denver, Col., who will continue the manufacture and sale of this well known machinery.

John W. Beam, formerly Sales Engineer with the Denver Engineering Works Co., will represent the Paxton & Vierling Iron Works with offices in Suite 810, Patterson Building, Denver, Col.

The Consolidated Asbestos, Ltd., has issued a small booklet descriptive of the asbestos industry in Quebec. It is splendidly illustrated and gives much information regarding the conduct of the business, going into analyses, grading, mining, milling and uses of the material. Altogether it gives publicity to an industry which needs all that it can get. The booklet may be obtained upon application to the company's offices in the Canada Cement Building, Montreal, Que.

A patent has been granted to Charles B. Waters, of the Waters Arc Welding Corporation, New York—a broad patent on the arc current welding transformer. The company will add to its present line, which consists of alternating current arc welding machines and supplies, a new line of direct current welding machines—both of the grid and motor generator types—as well as gas-driven welding machines.

Thomas F. Kelly, of Buffalo, New York, has been appointed manager of the Smelters' General Briquette Corporation, specializing in the manufacture of briquettes for smelting purposes—notably from iron flue dust. The new corporation has been organized to succeed the metallurgical department of the General Briquetting Company. Ellsworth B. A. Zwoyer, of Perth Amboy, N. J., has been appointed manager of the General Fuel Briquette Corporation organized to succeed the fuel department of the General Briquetting Co.

TRADE CATALOGS

Welding—The Metal & Thermit Corporation, New York, has issued a new Thermit rail welding pamphlet, which brings up to date the whole subject of Thermit rail welding to cover recent improvements in economy and efficiency. The pamphlet includes detailed instructions, accompanied by illustrations and drawings, showing steps in making the improved Thermit rail weld, which, it is claimed, has greatly reduced the cost per joint. Improved apparatus used in connection with the work is described in detail for the first time. The pamphlet has 72 pages.

Water Filters—Bulletin No. 501 of the Graver Corporation, East Chicago, Ind., describes water filters of the horizontal pressure type. It contains tables and facsimile blueprints intended to aid those designing plants and laying out new equipment.

Drilling Tools—"Big Blast Hole Drills" is the title of a 96-page pamphlet issued by the Sanderson Cyclone Drill Co., of Orrville, Ohio, makers of Cyclone drills. The "big hole" method of drilling and blasting is described and its application to quarry, open-pit mining and heavy rock excavation. Drills, traction machines, drilling tools and accessories are covered by the catalog. This is catalog B 45.

Dynamite—In a leaflet the Atlas Powder Co. of Wilmington, Del., reprints an extract from a report of the U. S. Bureau of Mines by S. P. Howell and J. E. Crawshaw, in which it is stated that the company recommends the use of dynamite cartridges of larger diameter because, as the diameter of cartridges of high explosives is reduced, the velocity, sensitiveness and efficiency is also reduced and the objectionable fumes that are given off when the explosive is detonated are increased.

Blowers—The general catalog of the American Blower Co., Detroit, Mich., has just come to hand. In its 100 pages an effort is made to show in a general way the various types of equipment made by the company and to furnish those not acquainted with the company's facilities and its products, information of a general nature. Detailed bulletins on all the equipment shown in the catalog can be obtained from the company.

Ball Mills—The Hardinge Company, New York, has just issued a leaflet giving dimensions and capacities of its conical ball and pebble mills. The advantages of the conical mill are recapitulated.

Electric Haulage—The Mancha Storage Battery Locomotive Co., St. Louis, Mo., has issued a card calling attention to the Mancha "electric mule," as it styles a particular haulage locomotive that it manufactures for use in metal mines.